PRICES AND INCOMES COMMISSION

Canada
[General publications]
[G-51]

Inflationary Process in North American Manufacturing

The Inflationary Process in North American Manufacturing

by

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«This is one of a series of studies prepared for the Prices and Incomes Commission. The analyses and conclusions of these studies are those of the authors themselves and do not necessarily reflect the view of the Commission».

"The research leading to this report has been financed by the Prices and Incomes Commission through a contract with the Institute for the Quantitative Analysis of Social and Economic Policy at the University of Toronto. Some of the research dealing with the United States was financed by the National Science Foundation of the United States."

Institute for the Quantitative
Analysis of Social & Economic Policy
University of Toronto
March 1972

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Ottawa, 1973

PREFACE

This research project was launched in the summer of 1970, and the work involved was carried out at the University of Toronto and the University of Michigan. This research was primarily financed under contracts between the Prices and Incomes Commission and the Institute for the Quantitative Analysis of Social & Economic Policy at the University of Toronto. Part of the work dealing with the United States was financed under a grant from the U.S. National Science Foundation (GS-3265). The financial support provided by both organizations is gratefully acknowledged. However, the views expressed are those of the authors and do not necessarily reflect the opinions of either the Commission or the Foundation.

The three authors collaborated fully in the overall design of the project. They discussed together the models developed and the implications of the empirical results obtained, and commented on various drafts of each other's work. Taylor took responsibility for the empirical work on the U.S. economy and prepared the final drafts of chapters six and seven. Turnovsky and Wilson shared responsibility for the empirical work on Canada and jointly prepared the final drafts of the remaining chapters. All three authors shared in the necessary editorial work.

Inevitably a project of this size could not have been completed without the help and co-operation of many individuals. In this respect we are particularly undebted to Phyllis Clark, Jan Duinker and George Ugray at Toronto for their excellent research assistance, and to Les Cseh for his programming work

in connection with the Canadian contract data. Trent Gow undertook responsibility for assembling the Canadian wage and employment data, while Don McFetridge developed the price indexes for Canada; both of these sets of data were constructed in connection with their own research projects. Gordon Cameron undertook some of the regression analyses using the Canadian data. Additional clerical assistance was provided by Khaja Sayeeduddin and Julie Marshall.

We also wish to acknowledge the helpful co-operation of Joseph Caluori of the Prices and Incomes Commission in the assembly of the data series required.

For research and secretarial assistance in connection with the U.S. work, we are indebted to Mary Freppel, Angelo Mascaro, Amy Perrone, Susie Rust, Daniel and Nicole Weiserbs, and especially to Janice Benaderet and Paul Sommers. We also wish to thank Richard Herstein for programming the computations. We are grateful to Otto Eckstein and James Craig of Data Resources Incorporated for providing access to their data on input and output prices for the U.S. industries.

Finally, we want to thank Annette Antkow, Leila Ganesh, Gay Kennard, Linda Kohn, and Jessie Leger for the excellent secretarial assistance they provided throughout this project.

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chapter one

INTRODUCTION

During the period 1969–1970, the Canadian Government attempted to control inflation by the application of restrictive monetary and fiscal policies on the one hand, and by an attempt to establish an incomes policy relying on voluntary guidelines on the other. Both of these policies are predicated upon two different, but not necessarily inconsistent, views about the causes of inflation. For monetary and fiscal policy to work, prices and/or wages must be sensitive to demand pressures. The costs as well as the benefits of these policies depend upon the demand sensitivities of wages and prices, since the extent to which unemployment rather than reduced inflation is the result of the policies and the amount of unemployment required to achieve a given reduction of price inflation both vary inversely with these demand sensitivities.

For incomes policies to work, on the other hand, a necessary (but obviously not sufficient) condition is that firms and/or trade unions must possess sufficient market power to have some discretion in setting or adjusting prices and arriving at agreements on wage contracts. If wages and prices are completely determined by market conditions, rather than by the discretionary decisions of managers or trade unions, then to adopt a policy which assumes that the discretionary decisions of firms and unions matter—at least in the short run—simply does not make any sense.

We define market power to exist when the decision makers in a market have some discretion to influence either wages or prices. Such markets may be contrasted with highly competitive markets where decision makers are closely

constrained by market conditions, and their range of choice regarding wages and prices consequently narrow.[1]

In the present context we are concerned not only with situations in which market power so defined exists in the long run, but also situations in which such power may only be effectively exercised in the shorter run. The fact that in a particular market prices must equal unit costs in the long run does not preclude the possibility that, for significant periods of time, firms may be able to raise prices in relation to costs. The fact that in the long run trade union power may be undermined by the entry of new non-union firms does not mean that the union cannot raise wages above competitive levels for significant periods of time.

Where market power exists in product and labor markets this does not mean that price and wage behavior is necessarily unpredictable. Rather, a different set of variables will be necessary to explain movements in wages and prices in such markets, and the dynamic structure of the models estimated may well be different.

An adequate assessment of the effectiveness of traditional demand restraint policies as well as an appraisal of the possible role for incomes policies, requires a careful empirical analysis of the precise causes of inflation and some quantitative information on the relative magnitude of their respective impacts. While a good deal of empirical research on inflation has been carried out over the years, the bulk of this research—with some notable exceptions—has been concentrated at the macro-economic level. Without denying the importance of this work, one can readily recognize that it does suffer from several shortcomings. In the first place, in order to implement any policy most effectively, it is important for the policy maker to have accurate information concerning the causes and magnitudes of the inflationary pressures at the industry level. Secondly, since macro-economic relationships involve aggregations of individual industry relationships, it is impossible to use aggregate data to test specific theories of the causes of inflation. For example if one were to hypothesize that prices in competitive industries are demand determined, while those in oligopolistic industries are cost determined, this could not be adequately tested at the macro-economic level which includes both kinds of industries and presumably would show both kinds of effects to be important. To test hypotheses such as these, a less aggregated approach is necessary. Thirdly, with some exceptions, most of the existing literature is partial, looking at one aspect of the inflationary process in isolation, and does not attempt to present a unified analysis of the inter-relationships which exist.

This study is an attempt to delve deeper into the inflationary process. Since wages, unit costs, and prices are interdependent, our approach is to construct and estimate an integrated model of the inflationary mechanism at the two-digit industry level within the strategic manufacturing sector. The model is estimated for both Canada and the United States. The derivation of a con-

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[1] This definition involves the specific application of Kaysen's definition of market power to wage and price decisions. For a definition and discussion of the concept of market power see Kaysen (1961) pp. 85–89.

sistent set of relationships connecting wages, prices, and productivity would permit an assessment of the impact on price and wage inflation of alternative policies domestically and of alternative developments abroad.

The main focus of the study is on studying the causes of inflation in Canada, but an analysis of U.S. manufacturing is included for two reasons. First, it is used to provide corroborating evidence for the hypotheses formulated and tested for Canada. Second, one of the issues which we investigate is that of international linkages and in particular the impact of U.S. inflation upon that in Canada. Thus if the linkages between Canada and the U.S. are strong, it is clearly desirable for the Canadian policy maker to have some understanding about the nature of the inflation in the U.S.

In constructing such a model there are several major policy issues which we have in mind, in particular:

1. Whether or not a Phillips-type trade-off exists between inflation and unemployment and, if so, whether it is stable in the long run.
2. The strength of the effects of inflationary expectations and the related issue of whether there is a "natural" rate of unemployment which is consistent with price and wage stability or with stable rates of inflation of prices and wages.
3. The extent to which prices are determined primarily by changes in costs (including international costs) rather than by changes in domestic demand. This question is of obvious relevance to the magnitude and timing of the effects of fiscal and monetary policies.
4. The extent to which wages respond to factors unrelated to current demand conditions of the labor market. This is not only of relevance to the trade-off between unemployment and inflation, but also provides some indication of the possible role of incomes policies in the form of wage guidelines. If it should turn out that wages respond only to the demand conditions in the labor market, then policies designed to affect these conditions must be relied upon as the primary counter-inflationary policies.
5. The measurement of international linkages between the Canadian and U.S. economies. This will indicate the extent to which inflation is outside the control of the Canadian government under a fixed exchange rate and the possible gains to be made from adopting a floating exchange rate.
6. An assessment of the direction and magnitude of effects of changes in direct taxes and interest rates upon wages and prices. Changes in direct taxes on labor income may induce unions to demand higher wages, and may affect wages in non-union sectors through their effects on the supply of labor. Increases in interest rates or in direct taxes upon corporations could cause price increases in those sectors where prices are constrained by the threat of the entry of new domestic companies. While our research on both of these issues is tentative, the results are sufficiently interesting to warrant their presentation.

These, then, are some of the policy issues to which our research findings are of relevance. However, we must caution the reader that our conclusions are necessarily qualified because our research bears only on the manufacturing sector. While this sector is strategic—particularly for the analysis of international linkages—we must remember that about three-quarters of Canada's gross national product is produced elsewhere. Furthermore, the conclusions we shall draw are basically qualitative—supported in some instances by illustrative calculations—rather than quantitative. A complete assessment of the quantitative impact of alternative policies would require a simulation analysis and is beyond the terms of reference which originally gave rise to this research.

THE SAMPLE PERIOD

As our sample period we have selected the period 1949–1969, which we analyze using quarterly seasonally-adjusted data. This is an interesting period to study since it includes three basically inflationary episodes, the Korean War; the late 1950s; and the late 1960s. At the same time we have two periods of falling or relatively stable prices which are also included, the first being the immediate post-Korean War period, and the second the period of relative stability in the early and mid-1960s.

Thus the period we have selected for analysis contains a good deal of variability, which of course is desirable in any statistical analysis. Unfortunately, however, there are some places where data limitations have precluded our being able to include the Korean war years and frequently the analysis can only commence in the early or mid-1950s. The exact periods of estimation are discussed at the appropriate places below.

As we have already mentioned, our analysis focuses on only the manufacturing sector. While this means that our coverage is incomplete, at the same time it does have certain important advantages. Data for the manufacturing sector are usually of substantially superior quality than are data for non-manufacturing industries. Secondly, the international linkages, which are one of the major objectives of study are undoubtedly strongest in the manufacturing sector.

One of the major problems we have encountered is the construction of a consistent set of two-digit industries for Canada. The problem occurs because of the changes in the Standard Industrial Classification (S.I.C.) of the two-digit industries which occurred during the sample period. On the basis of the 1948 S.I.C. the manufacturing sector was composed of 17 two-digit industries, but these were increased to 20 in the 1960 S.I.C. Moreover, the problem was complicated by the fact that some component three-digit industries were reclassified so that one could not simply obtain a consistent set of 17 industries based upon the 1948 groupings. Finally, even if this could have been achieved, it would have been less than satisfactory since current data are based on the 1960 S.I.C., so that updating of the data would have been rather inconvenient.

The method we have adopted for obtaining consistent series is described in detail in the Appendix, section 1. Basically we have used appropriate linking procedures to define a set of 15 industries which remain consistent over the period. We refer to these as the "major group industries" or occasionally as two-digit industries. The industries thus defined are related to the 1948 and 1960 S.I.C.'s as follows:

Code Used in This Study		1948 S.I.C.	1960 S.I.C.
01	Food and Beverages	1	1
02	Tobacco	2	2
03	Rubber	3	3
04	Leather	4	4
05	Textiles	5	5
06	Apparel	6	6,7
07	Wood & Furniture	7	8,9
08	Paper	8	10
09	Printing & Publishing	9	11
10	Metals	10,12,13	12,13,14,16
11	Transportation Equipment	11	15
14	Non-Metallic Minerals	14	17
15	Petroleum & Coal	15	18
16	Chemicals	16	19
17	Miscellaneous Industries	17	20

The numbering system we have adopted corresponds as nearly as possible with that used in the S.I.C.'s. As can be seen, 12 of our industries correspond exactly to two-digit industries, and three aggregations were necessary. These include apparel, which consists of knitting and clothing, and wood & furniture, both of which are separate two-digit industries. The most substantial aggregation occurs in the metals group, which consists of four two-digit industries: primary metals, fabricated metals, non-electrical machinery and electrical machinery. It was with respect to these industries that the major reclassifications occurred. As a result the metals group becomes the largest industry (about 26 per cent of shipments), but not much larger than the food and beverages industry (about 21 per cent of shipments).[2]

[2] Some idea of the relative importance of the industries can be obtained by comparing their employment or shipments as percentages of all manufacturing totals. Such figures are given in the Appendix, section 8.

OUTLINE OF STUDY

Following this introduction, chapter two develops an integrated model of wage, productivity, and price behavior which interact together in the course of the inflationary process. This chapter deals with each of these sectors in turn, and indicates how they form an inter-related system.

On the wage side, the major innovation of our work is the formal recognition of the existence of multi-period contracts and their incorporation into the estimation of the wage equations. Hitherto, this important institutional reality has typically been ignored or given unsatisfactory treatment in the existing literature. As our model shows, the effects of such contracts can be adequately captured by introducing variable-weighted distributed lags on the independent variables in the regression equations. These weights, which reflect the percentage of workers in each period under contracts signed at the various prior periods, are based on a large sample of collective bargaining agreements. These data are described in section 9 of the Appendix.

The price equation is much more straightforward, and can be described as a flexible mark-up model in which prices are determined in part by a mark-up on unit costs and in part by demand conditions in the product market and by international prices.

Apart from their own intrinsic interest, productivity functions need to be estimated in order to derive estimates of normal unit labor costs, a variable which many studies have suggested is of over-riding importance as a determinant of prices. As these studies have shown, because of cyclical influences, actual unit labor costs are a poor proxy for normal unit labor costs. Hence we need to estimate productivity functions which enable us to remove cyclical and random influences from the productivity measures. The resulting estimates of "normal" productivity are used with observed wage rates to construct the estimates of normal unit labor costs used in the price equations.

The core of our empirical work is reported in chapters three through seven. Chapter three reports the wage results obtained for Canada, discussing the equations for all manufacturing as well as those obtained for the component industries. A good deal of emphasis is placed upon evaluating the performance of our contract-weighted approach and we may state at the outset that the improvement in the results it yields justifies the additional work required. We also give some preliminary results on a neglected topic in wage determination—that of the role of direct income taxes. Here our results, while ambiguous, are provocative, and clearly indicate that this subject is deserving of more extensive analysis than we have been able to give it.

Chapter four presents the productivity results and describes how these equations are used to calculate normal unit labor costs. These results are then used in the following chapter as inputs into the price equations estimated for all manufacturing and the individual two-digit industries. One question to which some attention is devoted, is the consistency of the aggregate equation with those estimated for the component industries. Weighted averages of various industry

effects are calculated and compared with the corresponding total effect calculated from the aggregated equation directly. Some consideration is also given to the implied price dynamics and the implications of the results for pricing behavior.

Chapters six and seven present the empirical results for the U.S. On the whole the procedures used with the U.S. data are similar to those employed in chapters three to five for Canada, but there are necessarily some differences due to data availability and other empirical factors; these are discussed at length where they occur.

Chapter eight examines the question of international linkages between the U.S. and Canada. Our approach in this chapter is to take our preferred price and wage equations for Canada and then consider the effects on Canadian prices if wages and prices in the U.S. each increase by one per cent. This is studied under a number of alternative hypotheses regarding the behavior of price movements outside the manufacturing sector and strongly confirms the existence of significant impact of U.S. on Canadian wages and prices.

The following chapter is devoted to a comparison of the results obtained for the two countries, noting similarities and trying to explain differences. The concluding chapter considers the policy implications of the study as a whole.

Finally, the Appendix provides more detailed descriptions of the Canadian data, their sources and where necessary their construction. Throughout the text, these descriptions are kept to a minimum, with references being given to the Appendix where the need arises.

chapter two

THE THEORY OF WAGES, PRICES AND PRODUCTIVITY IN MANUFACTURING

INTRODUCTION

Wages, prices and productivity form an inter-related set of economic variables. In negotiating for higher wages, workers will likely take into account recent price changes as well as possibly their expectations about future price movements. Similarly, firms in deciding their pricing policy will take into consideration the behavior of unit costs. These in turn depend upon the rates at which the factors of production are paid—in the case of labor, the wage rate—as well as their respective trends in productivity. Thus, if labor has shown an increase in its productivity, the firm is able to absorb some wage increases without having to raise prices in order to maintain its profit margin.

This chapter develops an integrated theoretical model, describing the interrelationships which exist between wages, prices and productivity in the manufacturing sector. These models form the basis of the empirical work which we report in chapters three to seven, where we present results for all manufacturing, as well as for the component two-digit or major group industries. For much of the theoretical discussion one need not specify precisely at which level of aggregation one is working, in which case the same relationships apply at the aggregate level as well as for the individual industries. Where inter-industry effects necessitate a different specification at the individual industry than at the aggregate level, these are clearly indicated. Since the main focus of our empirical work is on the Canadian manufacturing sector, where the impact of international effects—particularly those from the United States—is very important, our models are specified to take these effects into account. In this respect, our U.S.

equations (which can essentially be regarded as applying to a closed economy) can be treated as special cases, by simply ignoring the international effects.

The remainder of this chapter is organized as follows. The second section discusses in some detail the theoretical issues underlying the wage equation. The main fact that must be taken into account in the specification of the wage equations is the institutional reality that the majority of workers employed in the manufacturing sector have their wages determined by formal multi-period contracts. Despite the importance of such contracts, their existence has nevertheless been virtually ignored in the existing econometric literature.[1] However, to incorporate adequately the existence and basic characteristics of contracts into an econometric analysis is itself an extremely difficult task. In section two we explain the development of the estimation model, at the same time indicating how we have been constrained by data limitations.

The third section develops the productivity functions which are required for the determination of normal unit labor costs, and the fourth section develops the price equations. In both cases the models developed are much more straightforward, so that the exposition is correspondingly briefer. An integrated model of the manufacturing sector is presented in the fifth section, and in the concluding section a brief discussion of some econometric issues is provided.

WAGE DETERMINATION

The recent interest in both the theory and empirical investigation of wage determination owes much of its origins to the seminal work of Phillips (1958) who discovered the existence of an inverse empirical relationship between the rate of change of money wages and the unemployment rate. Stimulated by his findings, other researchers have investigated this trade-off using data for a number of countries over various time periods.[2] In general, the inverse relationship originally obtained by Phillips for the United Kingdom has been confirmed, although subsequent work indicates that other variables, such as the profit rate and the rate of change of consumer prices, are also important determinants of money wage changes, leading to the so-called "extended Phillips curve".[3] While most of this work tends to be empirical, there have been significant advances on the theoretical side as well and some of the issues raised will be discussed in more detail below.

It is important that any econometric analysis of money wage determination should be carried out within a correctly specified institutional context. The key institutional fact which must be taken into account is the existence of formal contracts which typically extend over several periods of observations. It is fair to say that this important consideration is ignored—or at the very most is given very casual acknowledgement—in the bulk of the existing empirical work.

[1] There are some exceptions; see for example Levinson (1960) and Eckstein and Wilson (1962), and more recently Hamermesh (1970) and Sparks and Wilton (1971).

[2] For a summary of many of these studies see R. G. Bodkin, *et al.* (1966).

[3] See, for example, G. L. Perry (1966).

The standard procedure has been to express the percentage change in money wages as a function of current explanatory variables (sometimes taken to be four-quarter moving averages). This implicitly assumes that the length of the contracts are constant, coinciding with the period of observation, or perhaps that they are of four-quarter duration, depending upon the exact specification of the model.

While this is the assumption implicit in the majority of the existing empirical studies, it must be stressed that it does not deal adequately with a fundamental institutional fact. Approximately 70 per cent of the workers employed in the manufacturing sector in Canada belong to unions. These individuals have their wage changes determined by contracts which are negotiated periodically. Once a contract has been signed, the basic wage rates are determined and current economic conditions prevailing throughout the remaining duration of the contract cannot affect these rates.[4] What is relevant in determining changes in wage rates are the economic conditions prevailing at the time the contract is signed,[5] since these will presumably determine the bargaining strengths of both sides.

An early study which did attempt to incorporate the institutional reality of multi-period contracts into an econometric model is that by Eckstein and Wilson (1962). Their approach, which is based on the concepts of wage rounds and key groups, is valid only if contracts are clustered in time and if strong inter-industry linkages exist within the key group. While the evidence suggests that the approach adopted by Eckstein and Wilson for their "key group" may have been reasonably accurate for the period of their study, its applicability to other industries, to other periods of time, and in particular to industries in Canada, is not readily justified.[6] More recently, Hamermesh (1970) and Sparks and Wilton (1971) have attempted to take into account the institutional realities of bargaining by analyzing *negotiated* wage changes for a small sample of contracts. These are unquestionably valuable studies, but they are limited in coverage and suffer from the defect that, because of data limitations, they are restricted to examining changes in basic wage rates. As our analysis indicates, these are far removed from the changes in average earnings that are typically observed, and which are relevant for the determination of unit labor costs.

Our analysis of wage determination takes explicit account of the existence of multi-period contracts of varying length. Essentially we describe an aggregation procedure whereby the observed wage changes are related back to the changes specified by the various contracts signed at the different points in time. To do this we require data describing the proportions of individuals under contract at each point of time whose contracts were signed at the various points of time in the past. We have been fortunate to obtain the relevant data based on an extensive sample of contracts (described in the Appendix, Section

[4] As we discuss below, earnings can be affected through the phenomenon of "wage drift".

[5] It is, of course, also possible that due to decision lags, wage changes may also depend upon economic conditions prevailing in periods prior to the one during which the contract is signed.

[6] See McGuire and Rapping (1968) and Reuber (1970).

9), enabling us to derive estimates of these proportions. Even so, however, there are severe limitations to the quality and coverage of the data and as indicated in the section below, we are forced to make a number of approximations and assumptions in the course of our derivation.

Aggregation from Negotiated Wage Changes to Actual Wage Changes

The treatment of multi-period contracts is formalized in the following model.

Let (i) $R_{t,t-\tau}$ = average specified wage rate to take effect in time t by contracts signed τ periods in the past, at time $t-\tau$.

(ii) $k_{t,t-\tau}$ = percentage of individuals at time t under contracts signed at time $t-\tau$.

(iii) $W_{t,t-\tau}$ = actual average wage rate obtained during period t by individuals whose contract was signed at time $t-\tau$.

(iv) W_t = actual observed average wage level (in unionized sector) during period t.

Note that all these wage rates are described as averages so that we are in fact presupposing an aggregation over the individual contracts signed at the various points of time. We simply deal with the averages of these contracts. The quantity W_t is what is typically reported in the statistics as average hourly earnings (AHE) which purport to measure the current average wages.[7] Wage rates, however, are negotiated in terms of $R_{t,t-\tau}$ which are determined at the signing of the contract. Note that for a variety of reasons—particularly wage drift—it is possible for the *actual* wage rate received at time t by individuals who signed at time $t-\tau$, $W_{t,t-\tau}$, to differ from what was originally negotiated. Unfortunately, while $R_{t,t-\tau}$ and $W_{t,t-\tau}$ are in principle observable, in practice it is impossible to obtain reliable data on either. We obtained, however, reasonably reliable data on $k_{t,t-\tau}$ so that by postulating appropriate behavioral hypotheses about $R_{t,t-\tau}$ and $W_{t,t-\tau}$ we are able to derive estimating equations involving observable data, which embody the aggregation of contracts, at least to a first approximation.

The procedure is as follows. By definition, the observed wage rate at time t is a weighted average of all the actual wage rates received by the different groups of individuals under contracts signed at the different points of time.

That is, we have,

$$W_t = \sum_{\tau=0}^{n_t} W_{t,t-\tau}\, k_{t,t-\tau}\,, \tag{1}$$

where, W_t, $W_{t,t-\tau}$ and $k_{t,t-\tau}$ are as defined above, and n_t denotes the number of

[7] In the U.S. the typical wage variable used is straight-time earnings. In Canada, since no straight time earnings data are available, the typical variable used is gross average hourly earnings. Although we have constructed estimates of straight-time earnings for the Canadian manufacturing sector, the results presented in chapter three are based on gross average hourly earnings, since typical equations estimated for straight time earnings yielded very similar coefficients with a slightly worse fit. See also note 6 in chapter three.

periods in the past that the oldest contract still in effect during time t was signed.

Note that these weights, which add to unity, will in general change over time as the time distribution of contract lengths change.

Similarly, the absolute change in wages is a weighted average of all wage changes received by the different groups of individuals under contracts signed at different points in time:

$$\Delta W_t = \sum_{\tau=0}^{n_t} \Delta W_{t,t-\tau}\, k_{t,t-\tau}, \tag{2}$$

where $\Delta W_{t,t-\tau}$ is change in wages received (current wage less the wage of the preceding quarter) by individuals under a contract in effect at time t but signed during period t-τ.[8]

The relationship between the average percentage change in wages and the percentage change received by individuals under the various contracts is readily derived.

$$\Delta W_t/W_{t-1} = \sum_{\tau=0}^{n_t} (\Delta W/W_{-1})_{t,t-\tau}\, k_{t,t-\tau} \frac{(W_{-1})_{t,t-\tau}}{W_{t-1}}, \tag{3}$$

where $(\Delta W/W_{-1})_{t,t-\tau}$ is the average relative wage change specified in contracts signed in period t-τ and in effect during period t, and $(W_{-1})_{t,t-\tau}$ is the average wage in the previous quarter for workers under contracts signed in period t-τ and in effect in period t.[9]

This equation states that the percentage change in observed wages during period t (in the unionized sector) is a weighted average of the percentage changes in the actual wage rates obtained at time t by individuals whose contracts were signed at time (t-τ).

It is readily apparent that they are "wage bill' weights, which must add to unity. That is, in order to derive the percentage change in the observed wage rate at time t, the actual percentage wage changes received by individuals under contract signed at time (t-τ) and in effect in period t should be weighted by the percentage of the wage bill at time t-1 going to those individuals. Because reliable data in the wage bills under the various contracts could not be obtained we therefore approximate equation (3) by,

$$\Delta W/W_{t-1} = \sum_{\tau} (\Delta W/W_{-1})_{t,t-\tau}\, k_{t,t-\tau} \tag{4}$$

where the wage changes are weighted by the employment weights $k_{t,t-\tau}$. Pro-

[8]Note that the same weights $k_{t,t-\tau}$ are used in equations (1) and (2); i.e., the current distribution of employees under contract at time t is used to calculate the weighted average observed change ΔW_t.

[9]Note that $(W_{-t})_{t,t-\tau}$ differs from $W_{t-1,t-\tau}$. The latter variable is the wage rate in period t-1 for workers under contracts signed in period t-τ but in effect during period t-1. If some portion of the contracts signed in period t-τ expire at the end of period t-1, the workers involved are transferred to contracts signed in the current period t. Hence $(W_{-1})_{t,t-\tau}$ must be weighted by $k_{t,t-\tau}$ in calculating the observed average wage W_{t-1}, whereas $W_{t-1,t-\tau}$ must be weighted by $k_{t-1,t-\tau}$ in order to arrive at the same average wage.

vided that the variations over τ in $W_{t-1,t-\tau}/W_{t-1}$ are small in comparison with variations in $k_{t,t-\tau}$, this approximation should be reasonably satisfactory.

Equation (4) hence describes the aggregation procedure we have adopted. However, in order to derive an estimable equation we must hypothesize some relationship to explain the unobservable variable $W_{t,t-\tau}$ in terms of observable variables. To do this we first postulate the following relationship between $W_{t,t-\tau}$ and $R_{t,t-\tau}$ namely,

$$W_{t,t-\tau} = R_{t,t-\tau} D_{t,t-\tau} \tag{5}$$

where $D_{t,t-\tau}$ is a factor which describes "wage drift". Equation (5) asserts that the actual wage rate received at time t by those individuals who signed their contracts at time (t–τ) differs from the wage rate that was originally specified to come into effect at time t by a factor which reflects the amount of wage drift. This notion refers to the phenomenon that even though wage rates are determined for the duration of the contract at the time the contract is signed, nevertheless the earnings actually received at later dates within the contract may still be somewhat responsive to the economic conditions prevailing at those dates. This occurs primarily through the reclassification of workers, elimination of shift differentials, and the payment of overtime premiums. Contracts specify wage rates for different categories of labor so that by reclassifying workers, employers are able to affect the wage rate individuals receive and by altering the mix of individuals in the various skill categories, they can influence the average wage level. To take a concrete example, consider a contract which is signed at a time when economic conditions are bad so that the settlement is unfavorable from the point of view of the workers. If economic conditions improve during the life of the contract, so that an upward demand pressure is exerted on the labor market, entrepreneurs may be forced to grant larger wage increases than specified in the original contract. This may be done by giving more rapid promotions from one category to another or perhaps by upgrading employees' existing positions by nominally changing their titles.

However, $R_{t,t-\tau}$ and $D_{t,t-\tau}$ are still unobservable and we must therefore hypothesize some relationship for them. Taking percentage changes of (5) and ignoring terms of the second order, we obtain,

$$(\Delta W/W_{-1})_{t,t-\tau} = (\Delta R/R_{-1})_{t,t-\tau} + (\Delta D/D_{-1})_{t,t-\tau} \tag{6}$$

The term $(\Delta R/R_{-1})_{t,t-\tau}$ is the percentage change in the basic wage rate negotiated to take effect during period t for individuals whose contract was signed at time (t-τ). This is clearly determined at the beginning of the contract by those factors which determine the contract. Thus in order to analyze what factors determine these *specified* wage changes we must consider more carefully the key features that characterize a contract.

Basically the issues that should be taken into account are the following:

(i) specified wage increases to take effect immediately,

(ii) specified wage increases to take effect in the future,

(iii) escalator clauses tying wages to the cost of living,

(iv) annual improvement factors or other devices for effecting wage increases,

(v) changes in shift differential, holiday pay, etc. (i.e. all items which affect straight-time earnings as conventionally measured, and

(vi) changes in fringe benefits.

Because of data limitations we are forced to ignore changes in fringe benefits, although they are clearly important in many contracts. Secondly, we assume that items (ii), (iv), and (v) above can be combined into a single series, namely the $R_{t,t-\tau}$ for $t > \tau$. This means that a contract can be fully described in terms of its impact on wages by three factors,

(i) the immediate wage change—that specified to go into effect currently, retroactively or in the immediate future (e.g. within the quarter during which the contract is signed);

(ii) the stream of future specified wage changes, consisting of the vector of wage changes to go into effect during the remaining life of the contract;

(iii) the cost-of-living escalator which ties subsequent wage increases to cost of living increases as they occur.

We cannot proceed further without making specific assumptions about the relationship among these three aspects of a contract. We first examine contracts without escalators so that we can focus our attention on the relationship between current and future wage increases.

To be concrete, let us consider a three-year contract signed at time ($t-\tau$). Typically, this will specify a wage increase to go into effect immediately and will specify a number of wage changes to go into effect at different points of time in the future. For example it may specify a five per cent increase for the first quarter and additional five per cent increases to take effect during the fifth and ninth quarters. This would be quite plausible and would correspond to annual wage adjustments. Thus for the majority of quarters (2, 3, 4, 6, 7, 8, 10, 11, 12) a zero wage change is specified. Thus, as far as this individual contract is concerned, it specifies a "spiking" of wage changes. Changes come into effect only every fourth quarter—zero changes at all other times. If all contracts signed were of the same length, then one would expect the average contracts to exhibit the same phenomenon. Moreover, if as is frequently the case, the initial wage increase exceeds those specified to come into effect in the future—the case of front end loading—the spikes for the immediate wage change will tend to be larger than for those specified to take effect in the future.

While the spiking phenomenon is typical of most contracts, the representation of it presented above is an over-simplification. Because of delays in wage bargaining and because many contracts are not integer multiples of twelve months in length, delayed wage changes do not necessarily take effect only in the fifth, ninth, and thirteenth quarters of a particular contract.

As a result when we aggregate over contracts the average negotiated wage increase for each quarter will tend to smooth out and the spiking as a result to diminish. Furthermore, these average wage changes will tend to become even

more smoothed as more contracts of varying lengths are included in the aggregation. Thus at the other extreme we can assume that on the average all wage changes specified by the contract are evenly distributed through the life of the contract.

Let us denote the set of variables which determine the contract signed at time (t-τ) by $X_{t-\tau}$. (In the next subsection these will be discussed in more detail.) Thus if the smoothing assumption is regarded as an appropriate approximation, it follows that,

$$(\Delta R/R_{-1})^*_{t,t-\tau} = f(X_{t-\tau}) \qquad \tau = 0, 1, 2, 3, \ldots, \tag{7}$$

where $f(X_{t-\tau})$ is independent of t. On the other hand if the spiking approximation is more valid then we would have,

$$\begin{aligned}(\Delta R/R_{-1})_{t,t-\tau} &= 4f(X_{t-\tau}) \qquad && \tau = 0, 4, 8, \ldots, \\ &= 0 && \text{otherwise.}\end{aligned} \tag{8}$$

The truth of course lies somewhere in between, but for analytical reasons we are forced to adopt either one of these polar cases. As will be seen in our empirical chapters, the smoothing assumption proved satisfactory for the wage models for Canada but not for the United States, where the "spiking" approach was adopted.

However, there are situations in which the distributed lags implied by these two approaches are not too different from one another. Equations (7) and (8) assume that negotiated wage changes over a contract are determined uniquely by the values of independent variables during the quarter in which the contract is signed. Suppose, on the other hand, that the wage bargain itself depends on a four-quarter moving average of these variables. Then the results obtained by applying the "spiking" weighting scheme (8) to these four-quarter moving averages, may in fact be very similar to those obtained by applying the "smoothing" assumption (7) to the current values of these same variables.[10]

We now turn to the wage drift factor $D_{t,t-\tau}$. Basically what this factor is supposed to measure are the current effects of economic conditions as compared to what they were at the time the contract was signed. This will reflect the pressure on management to grant higher (or lower) wage increases than were originally specified, through accelerated (or retarded) promotions or upgrading.

We therefore postulate that the rate of wage drift depends on the difference between current economic conditions and the conditions prevailing at the time the contract was signed;

$$(\Delta D/D_{-1})_{t,t-\tau} = \beta[g(Z_t) - g(Z_{t-\tau})], \tag{9}$$

where Z_t denotes the set of variables measuring current economic conditions.

In this formulation the current rate of change in average hourly earnings therefore will exceed the rate of change specified in the contract when current economic conditions are more favorable than the conditions prevailing at the time of signing.

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[10] Because the estimating equation used for the wage models in the United States involves considerable smoothing of the data (four-quarter overlapping changes in the dependent variable; four-quarter moving averages of the independent variables), the contrast between the approaches used in the two countries should not be overemphasized.

Since the X's and Z's are observable, we are able to express the wage equation (4) in terms of observable variables. By substituting from (6) and (7) we obtain:

$$\frac{\Delta W_t}{W_{t-1}} = \sum_\tau f(X_{t-\tau})\, k_{t,t-\tau} + \sum_\tau \beta[g(Z_t) - g(Z_{t-\tau})]. \tag{10}$$

So far we have ignored the possible effects of escalator clauses, but as we indicate below, their effects can be easily included, at least approximately. Let us now turn to an examination of the determining variables themselves, and to the specification of the functional forms of f and g to be used in the econometric estimation.

Determination of Wage Contracts

The conventional approach to wage determination at the all manufacturing level in a closed economy is to postulate an "extended" Phillips curve relationship of the form:

$$\dot{W}_t = a_0 + a_1 U_t^{-1} + a_2 \pi_t + a_3 \dot{P}_t \tag{11}$$

where $\dot{W}_t$ = percentage change in money wage rates occuring during period t;

U_t = rate of unemployment during period t, taken to be a measure of labor market demand conditions prevailing at that time;

π_t = rate of profit, frequently measured by the gross after tax rate of return on stockholders' equity;

$\dot{P}_t$ = percentage change in consumer prices.

The rationalization for equation (11) has been described and critically evaluated in the literature. As it stands, this equation involves a misspecification of the lag structure of wage bargaining. However, if we interpret it as representing an equation determining currently negotiated wage changes, it is useful as a starting point for the discussion of the variables to be used in the estimation model developed below. We shall consider the relevance of alternative measures of labor market demand, profits, and consumer prices, and then consider a necessary modification for the wage equation in an open economy.

Most existing studies use the unemployment rate as a measure of labor market demand conditions. The basic rationale is that this variable, which is typically specified in reciprocal form, measures the relative pressures of demand and supply existing in the labor market. Hence, when unemployment is low, demand pressures in relation to the available supply result in wages being bid up; when unemployment is high, on the other hand, the supply pressures result in wages being bid down.

While such a rationalization has considerable appeal for a wage equation estimated for competitive labor markets (in which case it is a specific illustration of the traditional price adjustment process), it is not at all clear that this should

apply in a bilateral bargaining situation. To the extent that labor market demand matters to a trade union, it is probably the *employment of its own workers* that is relevant. A complete analysis of this question would involve formulating a multi-argument utility function for the trade union defined in terms of the wage level, employment levels of union workers, and other relevant factors. This would be an extremely difficult task, since little is known in quantitative terms about what factors enter unions' utility functions.

However, to illustrate what differences this approach might make to the estimating equation to be developed, let us assume that the union's utility function is of the form,

$$U(W, E; X),$$

where W = the wage rate

E = employment of union workers

X = other unspecified factors.

At any point of time the union confronts a demand curve for labor, and the tangency of this curve with the indifference curves derived from the utility function in (W, E) space will define the wage rate and employment objective of the union for that period. As the demand curve shifts through time the tangency curve also shifts, tracing out a locus relating changes in wage rates to changes in employment. Thus this argument implies that in a pure bargaining context, the change in employment, rather than the reciprocal of unemployment, may be the relevant labor market demand variable.

On the basis of this reasoning we therefore postulate the following alternative model:

$$\dot{W}_t = a_0 + a_1 \dot{E}_t + a_2 \pi_t + a_3 \dot{P}_t \qquad (12)$$

where $\dot{E}_t$ = the percentage change in production worker employment.

If the above equation is the appropriate wage model, and equation (11) (with U_t^{-1}) is estimated instead, it is quite possible to obtain apparently perverse signs on the unemployment variable, since $\dot{E}_t$ and U_t^{-1} may be negatively correlated.[11] Since which model is appropriate will depend on the strengths of the unions within a sector or industry as well as upon the adequacy of the aggregate unemployment rate as a measure of demand conditions in the relevant labor market, we estimate models based on both specifications for each industry or sector, as well as for all manufacturing.

The two equations, have, of course, vastly different dynamic implications for wage behavior. Equation (11) implies that a constant level of unemployment will *ceteris paribus* lead to continual changes in wages, so that labor market conditions exert a permanent effect on wage changes. On the other hand, equation (12) with employment change as the demand variable implies that the

[11] The sign on the coefficient on U_t^{-1} depends, of course, on the relation between $\dot{E}_t$ and U_t^{-1} and the remaining variables in the model. c.f. Henri Theil (1961).

effects of labor market conditions are strictly transitory. As long as employment remains constant, labor market conditions will not influence the outcome of wage bargains.

The rationale for the inclusion of a measure of profits in a bilateral bargaining model is three-fold. First, profits in excess of those required to pay the cost of capital form a target for union wage demands.[12] Second, profits measure a firm's ability to pay wage increases. When profits are high, wage increases can be absorbed partly in reduced profit margins. Moreover, to the extent that wage increases are passed on in higher prices under strong product demand conditions, little loss of output and employment will result. Third, and perhaps most important, increased profits weaken the strategic bargaining position of the firm relative to the union. The cost to the firm of a strike is the excess of sales revenues foregone over variable costs. These costs will obviously increase with an increase in total profits. As a result, when profits are high firms will be prepared to pay a larger premium—in the form of wage increases—to avoid a strike, and equally important, unions are most likely aware of this.

For these reasons we include a rate of profit variable in the general equation determining wages. Note that all the above rationales apply only for the inclusion of profits in a model of wage bargaining. It is difficult to provide any justification for the inclusion of profits in models of competitive labor markets. Only if one is prepared to adopt the rubric of identifying profits as a proxy for anticipated future labor market demand conditions should one include profits within a model of competitive labor markets.

An additional justification for the inclusion of profits applies only to certain industries in Canada. Where import limit pricing is pursued, the effective elasticity of the demand for labor will be very low until profit rates are driven close to the cost of capital. If profits are above this level, unions can confidently press their wage demands, since the increase in costs will not be passed on in prices, and no reduction in output or employment will result.

Finally, we should point out that for this variable, there is the possibility that there may be a *negative* bias in the estimated coefficients. Unit profits, unit labor costs, unit purchased input costs, and unit prices are linked by an identity. Given this identity, changes in wages and changes in profits will be negatively associated at given price levels. Any spurious relationship between wage changes and profit rates attributable to this identity will therefore likely bias the regression coefficient of wage changes on profits towards zero in a conventional model (or in the wage round model used by Eckstein and Wilson). In the models we estimate, however, this negative bias will be trivial because of the contract weighted distributed lag.

Following Eckstein and Wilson, we select as our profits variable gross cash flow net of income taxes expressed as a percentage of stockholders' equity. While examples of the use of other profit measures may be found in the literature, we believe that the form we select is most appropriate, for the following reasons.

[12] This is discussed at some length by J. D. Pitchford, (1963).

First, we feel that in a time series context a measure should be selected which is relatively invariant with respect to changes in accounting practices. Hence we use gross rather than net profits, since the latter would be affected by changes in accounting practices relating to depreciation of fixed capital. Second, we use a measure net of income taxes because this is a better measure of the costs to the firm of bearing a strike, and since firms' resistance to wage demands will likely stiffen as after-tax rates of return approach the cost of capital. Third, it is obvious that the use of absolute profits is inappropriate in a model predicting relative wage changes. Among the various relative measures, we select a rate of return measure in order to avoid possible biases involved in using profits per unit of output, and obvious difficulties in using profit margins on sales if capital intensity changes over time.

Much of the recent theoretical and empirical research in wage determination has revolved around the role and importance of the Consumer Price Index (CPI) as an explanatory variable. First, there is the question of its interpretation. Are workers seeking to be compensated for price changes which occurred since their last increase in wages or are they wishing to take into account price changes which they expect to occur in the future? Unless one has access to direct expectational data this kind of proposition is impossible to test. In the absence of such data, the typical procedure is to construct proxy or "pseudo" expectational variables by assuming that expectations of a particular variable are generated by a distributed lag on past actual values of the same variable. If one is forced to adopt such a strategy, it is impossible to distinguish the expectational information in these lags from the fact that they may simply reflect institutional lags in adjustment.

In two previous studies one of the present authors has investigated the role of current and expected prices in the wage equation using direct expectational data obtained every six months from surveys conducted in the United States.[13] These data were initially used in U.S. wage equations, but in view of the fact that the Canadian economy is so closely linked to the U.S. it was felt that they should serve as reasonably reliable proxies for expectations held by Canadians as well. Indeed this conjecture was strongly supported by the results and surprisingly enough, these survey data performed much better in Canadian equations than they did for the U.S. One of the conclusions emerging from these studies was that both expected price changes and a catch up for past price changes is important. However, partly because this question was investigated in some detail previously and partly because our present study is based on quarterly observations, for which no such expectational data exist, the role of expectations is pursued only indirectly here.

The second issue in the "expectations" discussion is the magnitude of the coefficient a_3 in equation (11). Authors such as Friedman (1968) and Phelps (1968) have argued that under competitive conditions and certainty, this coefficient should be unity, reflecting the fact that wage changes are negotiated in

[13] See Turnovsky (1972), Turnovsky and Wachter (1972).

real terms. This in turn would imply the absence of a long-run money wage unemployment trade-off, or equivalently would mean that the long-run Phillips curve is vertical, at the "natural" rate of unemployment. The Turnovsky (1972) paper indicates that this in fact turns out to be the case for Canada, for in the (statistically) most satisfactory equations the coefficient is insignificantly different from unity. For the U.S. on the other hand, Turnovsky-Wachter (*op cit* 1972) obtain a much smaller coefficient—of the order of 0.4—a finding which is confirmed by other studies (see R. J. Gordon, 1970).

In the case of Canada, equation (11) is usually modified to allow for the fact that Canada is so closely linked to the United States. Indeed the existence of such linkages may be one reason why the U.S. price expectations data worked so well in the Canadian wage equations. However, a more direct way of taking account of them is to introduce changes in U.S. wages as an additional explanatory variable into (11) and (12), yielding,

$$\dot{W}_t = a_0 + a_1 U_t^{-1} + a_2 \pi_t + a_3 \dot{P}_t + a_4 \dot{W}us_t \tag{13}$$

and,

$$\dot{W}_t = a_0 + a_1 \dot{E}_t + a_2 \pi_t + a_3 \dot{P}_t + a_4 \dot{W}us_t \tag{14}$$

where $\dot{W}us_t$ = percentage change in money wages occuring in the United States at time t.

The inclusion of U.S. wages in some form cannot be justified in the context of a conventional neoclassical model of the labor market, because labor markets for production workers in the two countries are distinct. Immigration restrictions as well as cultural preferences serve to prevent international labor flows from bringing the two markets into a joint equilibrium. Marginal effects of relative wage differentials on the inflow and outflow of immigrants and emigrants might be anticipated in the long run, but in the short run these effects are both small and likely to be swamped by other factors.

Within the context of bilateral wage bargaining in an open economy, however, an adequate rationale for the inclusion of this variable may be developed. Where the actual or potential competition from abroad is a major factor affecting firms' ability to pass on wage increases in prices, an increase in the costs of these competitors will reduce the elasticity of demand (at the existing wage); the trade-off between employment lost and wage increases gained faced by the union will therefore be shifted so as to encourage larger wage demands.[14]

Furthermore, in those industries where institutional linkages are strong, unions' preferences will not be invariant with respect to changes in U.S. wages. As Downie (1970) has demonstrated in detail for three important industries, pattern bargaining across the border appears to be important, and in two of these the objective of achieving "wage parity" with the U.S. is of some impor-

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[14] It might seem that prices abroad rather than wages abroad would be the more relevant variable. However, since wage bargains determine wage rates for several quarters into the future, cost changes may be a better indicator of effects on the competitive position of the industry over the life of the wage bargain.

tance. Hence increases in wages in the corresponding industry in the United States may induce unions to attach greater weight to wage gains relative to possible employment losses.

For both reasons we feel that the possibility of a U.S. wage spillover should be allowed for and we have incorporated it as indicated in equations (13) and (14). An alternative specification is to postulate that current wage negotiations are influenced by the relative wage position of the Canadian industry *vis a vis* its U.S. counterpart, (Wcan/Wus). It may be readily demonstrated that this alternative formulation implies that there is a stable long-run equilibrium relationship between wage levels in the two countries. Since we feel that such a constraint is inappropriate, we have adopted the formulations (13) and (14) which do not impose any such restriction.

As we have elaborated upon at length in the section above equations (13) and (14) involve a serious misspecification of the lag structure introduced through the bargaining process which determines the wage changes of production workers covered by collective bargaining agreements. Nevertheless, they do provide the motivation for the hypotheses which we use to explain currently negotiated wages. Accordingly, we specify the following equations determining negotiated wage rates:

$$(\Delta R/R_{-1})_{t,t-\tau} = a_0 + a_1 U^{-1}_{t-\tau} + a_2 \pi_{t-\tau} + a_3 \dot{P}_{t-\tau} + a_4 \dot{W}us_{t-\tau} \tag{15}$$

$$(\Delta R/R_{--t})_{t,t-\tau} = a_0 + a_1 \dot{E}_{t-\tau} + a_2 \pi_{t-\tau} + a_3 \dot{P}_{t-\tau} + a_4 \dot{W}us_{t-\tau} \tag{16}$$

At this stage there is one further point to be clarified. The assumption implicit in equations (15) and (16) is that wage negotiations depend only upon conditions prevailing in the period (quarter) that the contract is signed. This of course is just one of many alternative hypotheses that one could make. For example, one could postulate that negotiators base their decisions upon economic conditions prevailing over a longer period, say a year, or even perhaps over the entire period since the last contract was signed.

More complex forms of distributed lag relationship could also be examined. However, given the problems of front-end loading and spiking of delayed wage changes discussed above, one could argue that the distributed lag function used in the estimating equations below already make some allowance for the wage bargain itself being influenced by a moving average of recent values of the independent variables.

We consequently did not experiment with alternative hypotheses for the wage equations for sectors or industries in Canada. For the U.S., as is explained in chapter six, the results based on a straightforward application of equations derived from (15) and (16) were not satisfactory, and a different approach involving moving averages and spiked distributed lags was used.

Turning now to the wage drift factor, we usually measured $g(Z_{t-\tau})$ by the reciprocal of unemployment $(U^{-1}_{t-\tau})$ or by employment change $(E_{t-\tau})$. Thus our wage drift relationship (9) becomes:

$$(\Delta D/D_{-1})_{t,t-\tau} = \beta(U^{-1}_t - U^{-1}_{t-\tau}) \ , \tag{17}$$

with an analogous equation for employment change:

$$(\Delta D/D_{-1})_{t,t-\tau} = \beta(\dot{E}_t - \dot{E}_{t-\tau}) \tag{18}$$

We are now in a position to derive our wage equation for the unionized portion of the all manufacturing sector. Substituting for $\Delta R_{t,t-\tau}/R_{t-1,t-\tau}$ from (15) and $\Delta D_{t,\tau}/D_{t-1,t-\tau}$ from (17) into equation (10), we obtain:

$$\dot{W}_t = a_0 + a_1 \sum_\tau U_{t-\tau}^{-1} k_{t,t-\tau} + a_2 \sum_\tau \pi_{t-\tau} k_{t,t-\tau} + a_3 \sum_\tau \dot{P}_{t-\tau} k_{t,t-\tau} + a_4 \sum_\tau \dot{W}us_{t-\tau} k_{t,t-\tau} + \beta \left[U_t^{-1} - \sum_\tau U_{t-\tau}^{-1} k_{t,t-\tau} \right] \tag{19}$$

where use is made of the fact that $\sum_\tau k_{t,t-\tau} = 1$. This equation states that, apart from escalator clauses, the current rate of change in money wage rates is a variable-weight distributed lag function of the quantities determining current and past wage negotiations. We henceforth denote the application of this distributed lag transformation to an independent variable by a superscript *, and we refer to these variables as being "contract-weighted". If we assume that wage changes due to escalator clauses are dependent upon current changes in the CPI, then using this notation, (19) is modified to:

$$\dot{W}_t = a_0 + a_1(U_t^{-1})^* + a_2 \pi_t^* + a_3 \dot{P}_t^* + a_4(\dot{W}us_t)^* + \beta(U_t^{-1} - (U_t^{-1})^*) + a_5 \dot{P}_t \tag{20}$$

where the variable $(U_t^{-1} - (U_t^{-1})^*)$ enters because of wage drift. An analogous equation is obtained where demand conditions in the labor market are measured by employment change, namely

$$\dot{W}_t = a_0 + a_1 \dot{E}_t^* + a_2 \pi_t^* + a_3 \dot{P}_t^* + a_4(\dot{W}us_t)^* + \beta(\dot{E}_t - \dot{E}_t^*) + a_5 \dot{P}_t \tag{20'}$$

If all workers were covered by collective bargaining agreements, then equations (20) or (20′) would be appropriate equations for explaining all manufacturing wages. However, 30 per cent of production workers are not unionized. If the wages of these workers follow closely the wages determined under collective agreements, equations (20) or (20′) could be used for the wages of all workers. However, it may be more reasonable to allow for the possibility that the wage changes of non-unionized workers are determined by current economic conditions. In particular, we shall assume this part of the labor market can be described by neoclassical supply and demand relationships in conjunction with a conventional disequilibrium wage adjustment process (the original justification for the Phillips curve; see Lipsey (1960)), hence,

$$\dot{W}_t = a_0' + a_1' U_t^{-1} + a_2' \dot{P}_t \tag{21}$$

In this function a_2' indicates the extent to which the adjustment is in real rather than money terms. Profits are omitted from this equation on the grounds that product market conditions should not affect wage rates in this sector, except through their effect on the demand and supply of labor which are already measured by the unemployment rate and the rate of change of consumer prices. An analogous equation involving $\dot{E}_t$ instead of U_t^{-1} can also be specified, but in this instance the rationale is simply that $\dot{E}_t$ may better represent the pressure of demand on supply in the relevant labor market for the industry.

The average observed money wage rate in the manufacturing sector as a whole will of course be a composite of the two rates for the unionized and non-unionized employees. Assuming that the proportions of workers within these two groups do not change much over time, then the observed percentage change in the money wage rate should be a weighted average of the corresponding percentage changes in the money wage rates in the two sectors. Thus we are led to the following general estimating equation for the manufacturing sector as a whole,

$$\dot{W}_t = b_0 + b_1(U_t^{-1})^* + b_2\, U_t^{-1} + b_3\, \pi_t^* + b_4\, \dot{P}_t^* + b_5\, \dot{P}_t + b_6\, (\dot{W}us_t)^* \,, \tag{22}$$

where $\dot{W}_t$ now measures the average percentage change in money wages in the manufacturing sector as a whole.

An analogous equation applies to the case where $\dot{E}_t$ is used instead of U_t^{-1}:

$$\dot{W}_t = b_0 + b_1\dot{E}_t^* + b_2\dot{E}_t + b_3\, \pi_t^* + b_4\dot{P}_t^* + b_5\dot{P}_t + b_6(\dot{W}us_t)^* \,. \tag{22$'$}$$

The weighted variables refer to the changes occurring in the unionized sector, while the current values of explanatory variables refer partly to the non-unionized sector, partly to the phenomenon of wage drift in the unionized sector (U_t^{-1}), and partly to escalator effects ($\dot{P}_t$). Letting λ denote the percentage of unionized workers, then the coefficients of $(U_t^{-1})^*$ and U_t^{-1} in equation (22) can be related approximately to the corresponding parameters appearing in equations (20) and (21) by the following equations:

$$b_1 = \lambda(a_1 - \beta)$$
$$b_2 = \lambda\beta + (1 - \lambda)\, a_1' \,.$$

Note that even if we know λ, we cannot identify the three coefficients, a_1,β,a_1' and hence we are unable to isolate the effects of U_t^{-1} which are due to wage drift from those which reflect its influence on the wages of non-unionized employees. Note also, that if the wage drift effect is sufficiently strong, then it is quite conceivable for $b_1 < 0$, so that $(U_t^{-1})^*$ enters the regression with a perverse sign. This is quite apart from the reason for such a result, given earlier. Finally, the same problem of underidentification prevents us from isolating effects in the CPI due to escalators from those due to its influence in the wages of non-union employees.

Equation (22) forms the basis for our empirical work at the all manufacturing level. Numerous special cases of this model are used. Thus, for example, a domestic version—which also applies to the United States—is obtained by setting $b_6 = 0$.

Industry Wage Equations

Our final task in the specification of the wage side is the formulation of industry wage equations. The methodology here follows closely what we have been describing for the all manufacturing level. A major difference is in the specification of the determinants of the contract.

Specifically we assume that,

$$\frac{\Delta R_{i,t,t-\tau}}{R_{i,t-1,t-\tau}} = a_0 + a_1\dot{E}_{i,t-\tau} + a_2\pi_{i,t-\tau} + a_3\dot{P}_{t-\tau} + a_4\dot{W}us_{i,t-\tau} + a_5\left(\frac{W_i}{W_T}\right)_{t-\tau} \tag{23}$$

where the subscript i refers to the industry, W_i refers to the wage rate in that industry, W_T refers to the average wage rate in the all manufacturing sector as a whole. Thus negotiated wage changes depend upon the percentage change in employment in the industry, the industry's rate of profit, the percentage change in the CPI, and the percentage wage changes in the corresponding U.S. industry. In addition they depend upon a domestic "spill-over" variable, which describes the fact that the wage level elsewhere in the manufacturing sector will influence the wage paid in industry i. This can be formulated in two ways. First it can be described by the relative wage position of the industry, relative to all manufacturing, as we have done in (23). In this case $a_5 < 0$. If W_i/W_T is relatively large, so that industry i is a high wage industry, labor will be attracted to this industry, increasing the supply and reducing the resulting wage increases. An alternative formulation of the spill-over effect is in absolute form, where W_i/W_T is replaced by $\dot{W}_T$, the percentage change in money wage rate changes in all manufacturing as a whole. This hypothesis has also been used and in this case the corresponding coefficient should be positive, reflecting the fact that as the general wage level rises, each industry will increase its wages so as to maintain its competitive position *vis a vis* other industries.

It is also possible that wage drift in a particular industry will be affected by that industry's relative wage position. Thus for example, instead of (18) we might have:

$$(\Delta D/D_{-1})_{i,t,t-\tau} = \beta_1 \sum_{\tau} (\dot{E}_{i,t} - \dot{E}_{i,t-\tau}) + \beta_2 \sum_{\tau} \left[\left(\frac{W_i}{W_T}\right)_{t-1} - \left(\frac{W_i}{W_T}\right)_{t-\tau} \right] , \qquad (24)$$

where $\beta_2 < 0$. If over the period since the contract was signed, the industry's wage position has deteriorated, there may be a tendency for the management to try and grant larger increases than were initially negotiated.

Thus repeating the analysis carried out for all manufacturing, we obtain the following industry wage equation,

$$\dot{W}_{it} = b_0 + b_1 \dot{E}^*_{it} + b_2 \dot{E}_{it} + b_3 \pi^*_{it} + b_4 \dot{P}^*_t + b_5 \dot{P}_t$$

$$+ b_6(\dot{W}_{US\,it})^* + b_7\left(\frac{W_i}{W_T}\right)^*_t + b_8\left(\frac{W_i}{W_T}\right)_{t-1} . \qquad (25)$$

While the inclusion of $(W_i/W_T)_{t-1}$ as an explanatory variable may be justified in terms of wage drift, another reason for introducing this variable is to allow for the possibility that if the wages of non-union workers are not linked closely to those determined under collective agreements, they may never the less be influenced by the relative wage position of the industry.

Several variants of this equation have been estimated. First, U_t^{-1}, the reciprocal of the unemployment rate was used as an alternative labor market demand variable. Second, the spillover variable was sometimes described in absolute rather than relative terms, so that W_i/W_T is replaced by $\dot{W}_t$. Third, many variables were dropped when they turned out to be insignificant or of inappropriate sign.

THE PRODUCTIVITY EQUATIONS

The price equation described in the fourth section below is based upon the hypothesis that firms determine their prices by applying a mark-up on the total unit variable costs incurred when they are operating at some standard or normal rate of utilization of capacity. The calculation of the costs associated with this normal utilization rate requires, among other things, an explanation of variations in unit labor costs. This in turn necessitates an explanation of the cyclical changes in labor productivity so that the underlying productivity trends, which affect normal unit labor costs, may be identified. However, apart from being an important intermediate step in the derivation of our price equation, the productivity function is of interest and importance in its own right. In particular, it enables us to determine what wage increases can be tolerated without imposing inflationary price pressures in the manufacturing sector of the economy.

During the past few years, several empirical studies explaining the cyclical behavior of labor productivity or employment have been undertaken. Our productivity function follows the approach of Wilson and Eckstein (1964), which emphasizes the lags in adjusting the employment of labor to changes in output as being the price determinant of short-run productivity changes.[15] Since the same productivity function is used at the all manufacturing level, as well as for the individual industries, the following model applies to all levels of aggregation.

We begin by postulating that the long-run relationship between manhours and capacity output at time t can be described by

$$M_t^c = Ae^{-gt} C_t \,, \tag{26}$$

where M_t^c denotes equilibrium manhours,

C_t is capacity (expressed in output units),

g is the rate of increase of labor productivity, and

A is a constant.

This equation postulates that unit manhour requirements at full utilization of capacity are determined by a simple exponential trend. Hence it assumes that economies of scale are either absent or incorporated into the time trend, and that the substitution of capital for labor is either unimportant or else adequately represented by a time trend.[16] Empirical tests of these rather stringent assumptions are discussed briefly below.

Equation (26) describes the long-run equilibrium relationship between manhours and output that holds after all short-run adjustments have been completed. In any given period, however, the firm may plan to produce at some output other than capacity, thereby altering its demand for labor. We can describe this adjustment in its labor demand either logarithmically or linearly,

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[15] For other approaches see e.g. F. P. Brechling (1965), Edwin Kuh (1965).

[16] Obviously this equation may be derived from an underlying Leontief production function. However, it may also adequately represent a C.E.S. production technology if the substitution of capital for labor responds only to long-term trends in wage costs relative to capital costs.

though, of course, the two specifications yield somewhat different estimating equations. We have in fact used both versions, but shall only describe the former in detail. Denoting this planned output by Q_t^p, and the corresponding labor requirement by M_t^p, we assert that,

$$M_t^p = M_t^c \left[\frac{Q_t^p}{C_t} \right]^{\beta} . \tag{27}$$

Equation (27) implies a constant proportionate rate of adjustment in labor to any discrepancy between planned output and capacity. In particular, it implies that the elasticity of planned labor with respect to planned output is a constant β and this is referred to as the intermediate-run elasticity.

Because of short-run fluctuations, there is no need for the actual and planned outputs to be equal. In this case the actual manhours required M_t, to produce the actual output Q_t, is described by,

$$M_t = M_t^p \left[\frac{Q_t}{Q_t^p} \right]^{\gamma} . \tag{28}$$

Analogous to (27) this equation implies a proportionate adjustment in labor to any discrepancy between planned and actual outputs. The elasticity of actual labor given Q_t^p with respect to actual output is given by the constant γ.

As explained in chapter four, the productivity function is fitted to a variety of kinds of labor, namely to production workers and non-production workers, for both standard hours and overtime. Note that for production worker straight-time hours one would expect $\beta > \gamma$, since firms will have greater flexibility the longer the adjustment period. Also, since non-production workers are typically hired with longer-run horizons, one would expect $\gamma = 0$ in that case. This was in fact found to be the case at the all manufacturing level and so γ was set equal to zero for nonproduction workers in the industry equations. However, for overtime labor one would expect the inequality to be reversed. The reason for this is that in the short run much of the adjustment to fluctuations in output will take place in the number of overtime hours used. Since overtime hours are usually more expensive, in the long run the firm will adjust to any more permanent increase in output by increasing its use of standard hours of labor or altering in capital usage. Hence for overtime labor one would expect $\gamma > \beta$. However, since standard hours dominate overtime hours, one would expect the inequality $\beta > \gamma$ to be satisfied for the equation exploring total manhours.

From equations (26), (27), and (28), we obtain:

$$\frac{M_t}{C_t} = \frac{1}{A} e^{-gt} \left[\frac{Q_t^p}{C_t} \right]^{\beta} \left[\frac{Q_t}{Q_t^p} \right]^{\gamma} , \tag{29}$$

and taking logarithms leads to the estimating equation,

$$\ln \left[\frac{M_t}{C_t} \right] = \alpha_0 + \alpha_1 t + \beta \ln \left[\frac{Q_t}{Q_t^p} \right] + \gamma \ln \left[\frac{Q_t}{Q_t^p} \right], \tag{30}$$

where $\alpha_0 = \ln\frac{1}{A}\ \alpha_1 = -g$.

Equation (30) is the basic model underlying the empirical analysis of chapter four. However, a couple of further modifications were tried at the all manufacturing level. First, this equation is based on the assumption of constant returns to scale, and to test for the possibilities of scale effects we estimated the following equation[17] which includes the capacity index as an additional explanatory variable:

$$\ln\left[\frac{M_t}{C_t}\right] = \alpha_0 + \alpha_1 t + \beta \ln\left[\frac{Q_t^p}{C_t}\right] + \gamma \ln\left[\frac{Q_t}{Q_t^p}\right] + \varepsilon \ln C_t \qquad (30').$$

Since the coefficient ε turned out to be insignificant, suggesting that scale effects are unimportant this issue was not pursued further. Second, we tested to what extent current real wages may affect labor productivity (through its impact on the substitution of capital and other factors for labor), by including W_t/P_t as an additional explanatory variable. With the trend term included in equation (30), this variable was insignificant, suggesting any effects of real wages on the substitution of capital for labor are fully incorporated in the productivity trends.

The corresponding linear version of (30) is described by the following equation:

$$\ln\frac{M_t}{C_t} = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + (\beta_0 + \beta_1 t)\left[\frac{Q_t^p - C_t}{C_t}\right] + (\gamma_0 + \gamma_1 t)\left[\frac{Q_t - Q_t^p}{C_t}\right] . \qquad (31)$$

The preceeding remarks made about the speed of adjustments of the different kinds of labor apply here as well.

One attractive feature of the logarithmic equation is that the coefficients β and γ are elasticities, while $-\alpha_1$ measures the rate of productivity increase. With the linear function the corresponding elasticities and trends are somewhat more complicated to calculate, although they are permitted to vary with time. Specifically in the latter case we have the following:

1. The short-run elasticity, (defined as the elasticity of manhours with respect to actual output holding planned output and capacity constant) is given by,

$$\eta_\gamma = \gamma(t)\frac{Q}{M}, \qquad (32)$$

   where

$$\gamma(t) = \gamma_0 + \gamma_1 t .$$

2. The intermediate-run elasticity, (defined as the elasticity of manhours with respect to planned output holding capacity constant) is given by the expression,

$$\eta_\beta = \beta(t)\frac{Q_t^p}{M}, \qquad (33),$$

   where

$$\beta(t) = \beta_0 + \beta_1 t .$$

[17] We used this result to indicate that for our purposes equation (30) is adequate. The failure of this test to indicate economies of scale may simply reflect the usual difficulty of separating scale economy effects from the effects of long-run technical change with time series data.

3. The long-run elasticity of manhours with respect to capacity is unity by assumption (as it is for the logarithmic model as well).

Note also that, unlike the logarithmic case, the elasticity depends upon the relationship between Q, Q^p and C. We assume $Q = Q^p = C$ in evaluating the other two elasticities. Besides providing a standard point of reference for all three elasticities, this assumption also simplifies the calculations, for (32) and (33), are now reduced to,

$$\eta_\gamma = \frac{\gamma(t)}{\alpha(t)} \tag{34}$$

$$\eta_\beta = \frac{\beta(t)}{\alpha(t)} . \tag{35}$$

Finally the rate of productivity increase also depends upon the relationship of Q, Q^p and C. Again assuming that they are all equal, we find that,

$$\frac{(\dot{M/C})}{M/C} = \frac{\alpha_1 + 2\alpha_2 t}{\alpha_0 + \alpha_1 t + \alpha_2 t^2}, \tag{36}$$

which also depends upon t.

Finally, since the main purpose of introducing a productivity function is to estimate normal unit labor costs, we must briefly indicate how this variable is constructed. By definition actual unit labor costs are defined by the equation,

$$ULC_t = \frac{M_t W_t}{Q_t} . \tag{37}$$

As we have already discussed, normal unit labor costs are those actual unit labor costs incurred when the firm is operating at some normal rate, which we take to be at full utilization of capacity, and hence,

$$ULC^N_t = \frac{M^c_t}{C_t} . W_t . \tag{37'}$$

Thus, assuming the logarithmic formulation, we can substitute for M^c_t/C_t from (26), yielding,

$$ULC^N_t = Ae^{-gt} W_t , \tag{38}$$

where the relevant parameters A and g are estimated from the regression (30). The identical procedure is followed with the linear model.

THE PRICE EQUATION

In this section we derive a general model of price behavior which is applicable to both competitive and oligopolistic industries, and also makes allowance for the existence of import limit pricing in the latter. First, we derive an equation determining the long-run equilibrium price in the absence of import limit pricing. Then we modify the model to incorporate this type of pricing behavior. Finally, we derive an estimating model of pricing behavior in the short run which makes

allowance for the effects of excess demand and current changes in costs and international prices as well as for the adjustment of actual prices towards their long-run equilibrium values. Since we specify the same model for the all manufacturing level as for the individual two-digit industries, the following analysis applies in both cases.

Full cost or mark-up pricing has come to be regarded as characteristic of oligopolistic industries. The mark-up factor will be determined, under long-run profit maximizing behavior, by the condition of entry into the market and by the capital intensity of production. If neither of these factors change over time, we may derive the equation for the equilibrium price of firms which adopt a full cost pricing strategy on the basis of unit costs alone.

Under full cost pricing, the firm sets its price so as to achieve a desired mark-up on total unit variable costs incurred when it operates at some standard or normal rate. The reason for assuming that it is standard unit costs that are relevant is that the oligopolist is typically operating in an environment of uncertainty. One of the major problems confronting him is to determine how his competitors will react to his policies. Since he stands to lose both sales and customer goodwill if he raises his prices in response to short-run cost increases and finds that other companies do not follow, he will tend to view the pricing decision from a somewhat longer-term point of view. Consequently, the oligopolistic firm is likely to base its pricing decisions on those costs which it feels are permanent and are not consequences of random short-run fluctuations in the business cycle—in other words, on normal unit costs.

We assume that the firm has three variable factors of production: labor, domestically produced materials and imported materials. As we discussed in section three above, the unit cost of a factor of production is the cost associated with that factor for every unit of output. Denoting the unit costs associated with these three factors of production by ULC, UM_dC, and UM_iC, respectively, it follows that total unit variable costs UTC must necessarily satisfy the equation,

$$UTC = ULC + UM_dC + UM_iC \ . \tag{39}$$

The mark-up pricing rule asserts that a firm sets price so as to achieve a given mark-up on total unit variable costs, associated with some normal level of activity. Letting the superscript N stand for "normal" we therefore can describe this by,

$$P^* = \theta \ . \ UTC^N \ , \tag{40}$$

where

$$UTC^N = ULC^N + UM_dC^N + UM_iC^N \ , \tag{39'}$$

$\theta \geq 1$ is the mark-up factor and P^* denotes the equilibrium price set by the firm.

We now introduce some simplifying assumptions, namely that the shares of the three unit cost components in total unit normal costs are constant. Thus we assume,

$$\frac{ULC^N}{UTC^N} = c_1, \frac{UM_dC^N}{UTC^N} = c_2, \frac{UM_iC^N}{UTC^N} = c_3, \tag{41}$$

where $c_1 + c_2 + c_3 = 1$. These assumptions can be derived from the assumption of long-run profit maximizing behavior with an underlying (long run) Cobb-Douglas production function.[18] Using (41), it immediately follows from the mark-up hypothesis (40) that,

$$P^* = \theta c_1^{-c_1} c_2^{-c_2} c_3^{-c_3} (ULC^N)^{c_1} (UM_dD^N)^{c_2} (UM_iC^N)^{c_3} \tag{42}$$

Because of the short-run dynamics that we will be presently introducing, we must append time subscripts to the variables appearing in (42). Thus taking logarithms, the equilibrium price for period t is given by,

$$\ln P_t^* = c_0 + c_1 \ln(ULC^N)_t + c_2 \ln(UM_dC^N)_t + c_3 \ln(UM_iC^N)_t, \tag{43}$$

where c_0 is a constant and includes the terms $-(c_1 \ln c_1 + c_2 \ln c_2 + c_3 \ln c_3)$ as well as the constant component of θ.

We have already described our procedure for constructing normal unit labor costs, ULC_t^N, which are derived from the underlying productivity function developed in section three. As we have seen, this approach requires us to have estimates of employment and/or manhours, both of which are readily available. Unfortunately, the corresponding data are unavailable for domestic or imported inputs and it is difficult to separate the prices of imported and domestically produced materials. Consequently, we are unable to estimate either $UM_dC_t^N$ or $UM_iC_t^N$. We therefore assume that real materials inputs—both domestic and imported—remain constant per unit of standard output, and that a single price index may be used to represent changes in materials costs.[19] Equation (43) is hence rewritten as:

$$\ln P_t^* = b_0 + b_1 \ln(ULC^N)_t + b_2 \ln Pm_t, \tag{44}$$

where the constant b_0 is now defined to include the effects of unit materials requirements, and the variable Pm_t is the price index of all purchased inputs.

While the above equation would determine the prices of firms in oligopolistic sectors which use constant mark-up pricing, it may also be an adequate representation of the long-run equilibrium price for the more competitive industries. For competitive industries which produce under constant costs conditions in the long run, the equilibrium price must equal long-run average costs with allowance for normal profits. Hence the same form of equation may be used to determine the equilibrium price for those manufacturing industries which are competitive.[20]

Let us now modify this equation to incorporate an allowance for the effects of import limit pricing or more generally, for international competitive price influences.

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[18] Note that this assumption is not inconsistent with the productivity models described above.

[19] As will be discussed below, the corresponding output price in the U.S., which is intended primarily to allow for international competition influences in output prices, may also reflect the effects of changes in the prices of imported materials, particularly for the equation for all manufacturing.

[20] The oligopolies will likely differ from the competitive industries through having a larger mark-up factor for a given capital intensity.

Prices abroad can be expected to have a two-fold effect on domestic prices. First, they will have direct cost effects analogous to those of labor and domestic materials, and these are perfectly straightforward. Second, where entry limit pricing policies are followed, the mark-up factor will itself be affected by the conditions of entry, the cost conditions of entrants in relation to the cost conditions of established producers, and the price elasticity of industry demand. Furthermore, the extent to which cost changes may be shifted forward in price changes depends on the extent to which the cost change is shared by potential entrants.

In an open economy, such as Canada, two classes of entrant must be considered:

(a) new firms which enter production within the domestic market;

(b) competing products from comparable industries from abroad which enter the domestic market.

The entry inducing price for entrants of type (a) will depend on the traditional factors originally enumerated by Bain (1956)—absolute cost disadvantages of entrants relative to established producers, product differentiation, absolute capital requirements for entry, and economies of scale in relation to the market. In this connection, we note that the entry inducing price will also depend on tax factors and interest rates, which affect the cost of capital to the new entrant. In contrast to the traditional factors enumerated by Bain, which one would expect to vary only gradually over time, tax rates and interest rates may be important in a time series context. Some consideration of the effects of these variables is given in chapters five and seven.

Perhaps more important in the Canadian context is the second type of entry. If prices are primarily constrained by the possibility of imports entering (or substantially expanding their share of) the domestic market, variables which reflect the prices or costs of competing foreign producers may be expected to have direct effects on corresponding Canadian prices. Under these conditions, the effects of changes in domestic costs on prices will depend on whether the cost changes are shared by foreign producers. If Canadian wage rates rise but U.S. prices and wages remain constant, for example, little effect on Canadian prices may result. On the other hand, if the world price of an internationally traded raw material rises, full forward shifting of the cost increase may be anticipated.

As noted above, equation (44) is appropriate only if the variables determining the mark-up do not change over time. For an industry subject to actual or potential competition from abroad, this will clearly not be the case. We therefore modify equation (44) by incorporating a term reflecting the price in Canada of products imported from abroad. To measure this effect we use the price of output for the corresponding U.S. industry adjusted for the Canadian exchange rate. Introducing this variable into equation (44) we obtain:

$$\ln P_t^* = b_0 + b_1 \ln ULC_t^N + b_2 \ln Pm_t + b_3 \ln(Pus.r)_t \,. \qquad (45)$$

A word of caution regarding the interpretation of equation (45) should be given at this stage. At the all manufacturing level the materials price index consists almost entirely of domestic inputs. All manufactured imports, including competing imports, are netted out. This means that the cost effects of inflation abroad will be reflected in the term ln(Pus.r), which at the same time will also reflect the effects of foreign competition. On the other hand, at the industry level, the industry input price indexes include some imported manufactured goods. Hence, the cost effects of foreign inflation will be shared by the terms lnPm and ln(Pus.r). Thus at the industry level the U.S. price will probably reflect the effects of foreign competition relatively more heavily than it does at the all manufacturing level.

Neither of these procedures provide perfect measures of the inflationary pressures imported into the Canadian manufacturing sector from abroad. In the first place, they ignore the inflation in countries other than the U.S. Moreover, they do not reflect the inflationary effects imported into the Canadian manufacturing sector from the non-manufacturing sector in the U.S. and elsewhere. On the other hand a more aggregate measure of foreign prices would be no better, since it would include many items imported into Canada which go to the non-manufacturing sector.

Short-Run Price Adjustments

Equation (45) describes the long-run equilibrium relationship between prices and unit costs and international prices. In order to capture short-run disequilibria in prices we assume a short-run loglinear adjustment process:

$$\Delta \ln P_t = \gamma_1 [\ln P_t^* - \ln P_{t-1}] + \gamma_2 \Delta \ln ULC_t^N + \gamma_3 \Delta \ln Pm_t + \gamma_4 \Delta \ln(Pus.r)_t . \quad (46)$$

The first term represents the discrepancy between the equilibrium price for period t and the actual price prevailing during the previous period. It represents the usual kind of partial adjustment model, described logarithmically. In addition the changes in costs are introduced directly, asserting that changes in costs affect prices directly and not only through their effect on the equilibrium price level. An advantage of introducing the changes in costs directly is that it permits the ratio of the short to the long-run elasticities of price with respect to the various cost elements to differ, thereby avoiding one of the inflexibilities inherent in the usual partial adjustment models. Thus, for example, from equations (45) and (46) we see that the short and long-run elasticities of price with respect to unit labor costs are given by $(\gamma_1 b_1 + \gamma_2)$ and b_1, respectively. Hence $\gamma_2 > 0$ implies that the ratio of the short-run to long-run elasticity with respect to unit labor costs exceeds that implied by the pure partial adjustment model; if $\gamma_2 < 0$ the opposite is true. Note that in order to ensure that the short-run elasticity of price is positive, this implies a restriction of $\gamma_2 > -\gamma_1 a_1$ on the coefficient of $\Delta \ln ULC_t^N$ in the regression. However, a negative value for γ_2 is also plausible and implies a relatively sluggish short-run adjustment on the part of the firm.

Let us now examine the effects of demand conditions upon the pricing decision. Consider a market initially in equilibrium when demand increases. Producers may respond to this situation by,

(1) reducing final inventories below their desired equilibrium levels,
(2) increasing the backlog of unfilled orders above their desired equilibrium level,
(3) increasing output to try to meet the demand,
(4) raising prices.

Producers' primary immediate response to this situation may be through selling from inventory or allowing order backlogs to increase, since the increase in demand may well be transitory. If the demand increase persists, however, these two policies will give rise to a growing disequilibrium in that order backlogs will exceed or inventory/sales ratios fall short of their desired levels.

In the short run, it is therefore reasonable to postulate that prices of competitive industries may respond to demand conditions as measured by inventory or orders disequilibria. The extent of the price increase in such industries will of course depend on the shape of the short-run marginal cost curve of the representative firm. Under conditions of near constant short-run marginal costs, a competitive industry will respond to excess demand primarily by increasing output rather than prices. On the other hand, if short-run marginal costs increase sharply with output, the primary response will be a higher price rather than increased output. The case for inclusion of excess demand variables of the type described below in pricing models for competitive industries is therefore straightforward.

Let us now consider whether demand conditions are also relevant for the short-run price adjustments of the more oligopolistic industries. When demand increases, an oligopolistic group may well choose one or more of the first three responses listed above, since increases in price may be difficult to achieve because of the uncertainty that each producer will follow a price increase initiated by another, and because an increase in price may tend to encourage the entry of new producers or increases in imports.

On the other hand, output increases and sales from inventory may involve short-run costs which become increasingly important as excess demand increases. Hence at some point the possible short-run benefits of using a price increase to ration demand may outweigh the two disadvantages mentioned above.

While increases in the order backlog do not involve such increases in short-run costs, a long queue of unsatisfied customers may be a more effective inducement to new entrants than would be a higher price.[21]

Finally, in many oligopolistic sectors, the effective price may be altered through changes in transport charges, service charges, financial terms, and so

[21] For an early empirical analysis which documents the demand sensitivity of prices of machinery products, most of which are produced to order, see T. A. Wilson (1959).

forth. Charges for these "extras" may be more readily adjusted in response to demand conditions than formally quoted list prices.[22]

We therefore feel that it is appropriate to include measures reflecting demand conditions in price equations for oligopolistic industries, as well as for competitive industries. In particular, we assume that the partial adjustment of prices to demand conditions in a market may be described by the simple relationship:

$$\Delta \ln P_t = \beta \ln X_t \tag{47}$$

where X is a measure of excess demand, and $\beta \geq 0$.

The question of obtaining an adequate proxy for excess demand is therefore an important one and the appropriate measure will depend upon the characteristics of the industry being investigated. If the industry is one in which the firms produce to stock then some measure of inventory disequilibrium is appropriate. If it is one in which firms produce to order, then a measure of unfilled orders disequilibrium should be used. Because of aggregation, particularly at the all manufacturing level, both measures may be necessary and this is even true in many of the two-digit industries.

The exact form of the excess demand variables we have adopted are described in detail in chapters five and seven. Basically we have constructed proxies for inventory and unfilled orders disequilibria by taking ratios of actual values to moving averages of these variables. Previous studies have sometimes used capacity utilization as a proxy measure for demand pressures. In fact, how the firm decides to respond to demand pressures will depend in part on how much excess capacity it has. If demand increases when capacity utilization is low, the firm will probably respond by increasing the output to meet the additional demand. In this case the demand pressure is unlikely to be reflected in any inventory or unfilled orders disequilibrium. On the other hand in times of high capacity utilization, the option of increasing output is virtually precluded to the firm so that any attempt to meet demand must involve running down inventories or lengthening the backlog of unfilled orders. Thus in order to take account of the effects of capacity utilization, one approach is to construct a variable which measures the interaction of these disequilibrium measures and capacity utilization. This was in fact done at the all manufacturing level for Canada, but since the results were inferior to those with the simpler disequilibrium measures, this approach was not pursued.

Combining equations (46) and (47) we obtain our price equation in the form,

$$\begin{aligned} \ln P_t = {} & d_0 + d_1 \ln(ULC^N)_t + d_2 \ln Pm_t + d_3 \ln(Pus.r)_t + d_4 \ln X_t \\ & + d_5 \Delta \ln(ULC^N)_t + d_6 \Delta \ln Pm_t + d_7 \Delta \ln(Pus.r)_t + d_8 \ln P_{t-1}, \end{aligned} \tag{48}$$

where the excess demand variable X_t represents one or more of the alternatives examined in chapters five and seven. However, it must be stressed that since we have used measures of inventory and unfilled orders disequilibria, demand

[22]The extent to which Statistics Canada selling price statistics, and the U.S. commodity price statistics capture such practices cannot be readily ascertained.

conditions have strictly transitory effects. In a long-run equilibrium, when inventories and unfilled orders are at their desired levels, the influence of excess demand necessarily disappears and hence can have no effect on price movements in either competitive or oligopolistic industries.

Special cases of this general model may be obtained by suppressing or constraining certain coefficients. For example, the simple mark-up model may be obtained by suppressing demand effects and international price effects and assuming that there are no lags in the adjustment process. A pure import limit pricing model, on the other hand, would be obtained by suppressing all variables except the corresponding international prices. A simple excess demand model would be obtained by suppressing the cost and international price effects.

Because the two-digit industries and larger sectors which we examine will likely include a wide variety of market structures and of pricing behavior, we do not estimate each of the interesting special case models themselves. Instead, we estimate the general model and then suppress those coefficients which were unimportant or of inappropriate sign in obtaining the preferred equations which are reported in chapters five and seven below.

AN INTEGRATED MODEL OF WAGES, PRODUCTIVITY AND PRICE BEHAVIOR IN THE MANUFACTURING SECTOR

We shall complete this theoretical discussion by summarizing the basic integrated model of wage-price-productivity behavior.[23] Since the inter-relationships can be most easily seen by looking at the all manufacturing level, we shall restrict ourselves to that case. Needless to say, similar interactions exist at the individual industry level and these interdependencies can be traced out in a similar manner.

On the basis of the models developed in sections two to four above, we have the following equations explaining wages, productivity and prices, which in the case of Canada can be expressed in the following general form:

$$\dot{W}_t = b_0 + b_1(U_t^{-1})^* + b_2U_t^{-1} + b_3\,\pi_t^* + b_4(\dot{CPI}_t)^* + b_5\dot{CPI}_t + b_6(\dot{W}us_t)^* \tag{22}$$

$$\ln\left[\frac{M_t}{C_t}\right] = \alpha_0 + \alpha_1 t + \beta\ln\left[\frac{Q_t^p}{C_t}\right] + \gamma\ln\left[\frac{Q_t}{Q_t^p}\right] \tag{30}$$

$$\begin{aligned}\ln P_t = d_0 &+ d_1\ln(ULC^N)_t + d_2\ln Pm_t + d_3\ln(Pus.r)_t \\ &+ d_4\ln X_t + d_5\,\Delta\ln(ULC^N)_t + d_6\,\Delta\ln Pm_t \\ &+ d_7\,\Delta\ln(Pus.r)_t + d_8\ln P_{t-1}\,.\end{aligned} \tag{48}$$

For the sake of clarity here we are denoting the percentage change in the CPI by $\dot{CPI}$, so as to avoid any possible confusion with the output price in all manufacturing which appears in equation (48) as P_t. The link between the price

[23] For a similar kind of integrated aggregate model see Otto Eckstein (1964).

equation and the productivity and wage equations is through normal unit labor costs, which as discussed above are defined by

$$ULC_t^N = Ae^{-gt} W_t, \tag{38}$$

where A and g are estimated from equation (30).

It should be stressed that four equations (22), (30), (38), and (48) form only a partially integrated model of the manufacturing sector. Output which feeds into the productivity equation, product demand (reflected via inventories or unfilled orders) which feed into the price equation, and unemployment and profits which are determinants of wage changes are all taken to be exogenous. In fact, these variables are themselves endogenously determined and a fully integrated model of the manufacturing sector as a whole would have to analyze how they they are determined as well. Clearly such an extension to our present model would be extremely useful, but unfortunately it would take us far beyond the intended scope of the study.

However, for illustrative purposes it may be useful to trace out the resulting flow of responses resulting from a shift in one of the exogenous variables. For example, let us consider the effects of an increase in product demand. From the price equation we see that the initial impact is to create an inventory and/or unfilled orders disequilibrium as producers attempt to meet the demand by running down inventories or increasing the backlog of unfilled orders. The short-run effect of this is to lead manufacturing producers to raise their prices. This increase in prices in the manufacturing sector will contribute to an increase in the CPI and will thus feed into the wage equation. However, the change in the CPI which occurs during that period, will, under the assumptions of our model, only affect the wages of those individuals whose contracts are signed during that period, and which therefore are determined by the economic conditions which prevail then. Thus the effect of the rise in the CPI on the observed wage changes of that period will depend upon the relative importance of those individuals in the total labor force. Moreover, the total effect on the wage changes of those individuals will only take place with a lag, since part of the wage increases specified for these individuals will only take effect in the future. Indeed the adjustment of these workers' wages will only be completed when their contracts expire. This increase in negotiated wages leads to increases in normal unit labor costs (assuming that productivity remains the same) and thus feeds into the price equation. This will cause a further increase in prices which feeds into the wage equation as before. Furthermore, this process is repeated with those workers up for renegotiation, as long as the disequilibrium persists and manufacturers feel under pressure to raise prices. Eventually, however, the disequilibrium will be corrected and, even though there will be no further pressure to increase prices, nevertheless higher wages and therefore higher prices will have resulted from the temporary disequilibrium.[24]

[24] Similar responses in Canada resulting from changes in U.S. price and wage changes are traced out in some detail in chapter eight.

SOME STATISTICAL CONSIDERATIONS

Before turning to the empirical results, we briefly discuss the methods of estimation that have been employed and the criteria that have guided our efforts in arriving at the final equations. We have used single equation estimation techniques throughout, usually ordinary least squares, but augmented where appropriate by either Hildreth–Lu or Cochrane–Orcutt transformations to adjust for possible autocorrelation in the error terms.[25] For reasons which are discussed in chapter six, generalized least squares estimation is used for the final U.S. wage equations. Since we have argued above that the equation for manufacturing wages, prices and productivity form an integrated system, it might appear that our use of single equation estimation methods may introduce simultaneous-equations biases into the results.

Strictly speaking, this is correct. However, because the weight of manufacturing prices in the total Consumer Price Index (CPI) is only about 25 per cent, and because the CPI enters the wage equation with a rather extended distributed lag, it follows that the current CPI will have only small effect on current wages. The extent of simultaneity between prices and wages in the system as specified is thus in fact very small and to a close first approximation, the system can therefore be regarded as recursive. Productivity (which is determined exogenously), together with wages (determined partly exogenously and partly by the CPI) feed into the price equation in the form of normal unit labor cost. Normal unit cost in conjunction with other exogenous variables, then determines the price of manufactured output, again with a distributed lag. This price affects the CPI, and hence affects wages. However, because of these distributed lags, *immediate* feedback—which is what creates any simultaneous-equation bias—is trivial. This being the case, single equation estimation techniques may be used.

Another source of simultaneous equations bias involves the treatment of profits as an exogenous variable in the wage equations. While the change in profits is obviously affected by changes in prices and wages, any simultaneous-equations bias should be very small, since (a) the level of profit rates rather that the change in profits is the independent variable in the wage equation, and (b) profits, like consumer prices, always affect wages with a long distibuted lag.

Other sources of simultaneous equations bias exist, since other variables treated as exogenous in our system (changes in employment, purchased input prices, orders, and inventories) would of course be endogenous within a larger model. This is a characteristic shared by most partial analyses. However, since the equations are estimated for sub-sectors of the economy (with the largest, the manufacturing sector as a whole, accounting for about 25 per cent of gross national product), such simultaneous equations bias will likely be much smaller than for partial wage-price analyses at more aggregative levels. Furthermore, the existence of distributed lags in both the wage and price equations may be expected to reduce substantially any biases from these sources.

[25] See e.g. Hildreth-Lu (1960), Malinvaud (1970) for a description of these methods.

In the various chapters which follow, we frequently present sets of "preferred equations" which are derived from more general models by omitting or constraining selected coefficients. In general, our procedure has been to retain variables if their t-ratios are greater than one, provided that the direction of their effect is as hypothesized. The rationale for the use of this criterion is the well known fact that inclusion of any variable with a t-value greater than one results in a decrease in the unbiased standard error of estimate. We frequently describe such variables as being "marginally significant or important". When the t-value is greater than two we follow the conventional practice of referring to the variable as significant. Occasionally, however, we include variables with t-values below unity, where the direction of response is appropriate and where the inclusion of the variable is desirable on theoretical grounds.

We are, of course, fully aware that the strict application of conventional tests of significance is—as is usual with time-series econometric work—not appropriate. On the other hand, the fact that our models are typically estimated for several industries or sectors in each country lends additional support to the inferences drawn.

chapter three

WAGE BEHAVIOR IN CANADIAN MANUFACTURING

INTRODUCTION

We now turn to the empirical results obtained for the first component of our integrated model, the determination of money wages. As was discussed in the previous chapter, we specify the following two alternative general models at the all manufacturing level:

$$\dot{W}_t = b_0 + b_1(U_t^{-1})^* + b_2U_t^{-1} + b_3\pi_t^* + b_4\dot{P}_t^* + b_5\dot{P}_t + b_6(\dot{W}us_t)^*, \tag{1}$$

and,

$$\dot{W}_t = b_0 + b_1(\dot{E}_t)^* + b_2\dot{E}_t + b_3\pi_t^* + b_4\dot{P}_t^* + b_5\dot{P}_t + b_6(\dot{W}us_t)^*, \tag{2}$$

where

- $\dot{W}_t$ = percentage change in money wages occurring during period t,
- U_t = rate of unemployment during period t,
- π_t = rate of gross profit, measured by the sum of after-tax profits and depreciation divided by stockholders' equity,
- $\dot{P}_t$ = percentage change in the consumer price index,
- $(\dot{W}us_t)$ = percentage change in money wages occurring in U.S. manufacturing at time t,
- $\dot{E}_t$ = percentage change in the employment of production workers,
- $*$ denotes that the contract weights have been applied to the corresponding variable and we therefore refer to it as being "contract weighted".

These equations form the basis of our empirical estimation for all manufacturing. As discussed in chapter two, the current values of some of the variables—particularly the unemployment rate or employment change—may reflect either the wage behavior of the non-unionized portion of the manufacturing work force or wage drift in the unionized sector. If wages of non-unionized workers followed exactly those of unionized workers it would then be true that the current variables would be reflecting only wage drift. If further, the effects of wage drift can be adequately measured by the difference between current labor market conditions and those prevailing at the signing of the various contracts, equation (1) can be written in the form:

$$\dot{W}_t = b_0' + b_1'(U_t^{-1})^* + b_2'(U_t^{-1} - (U_t^{-1})^*) + b_3'\pi_t^* + b_4'\dot{P}_t^* + b_5'(\dot{W}us_t)^* . \quad (1')$$

The point of writing the equation in this form, which is of course equivalent to equation (1), is to highlight the impact of wage drift.[1]

The major difference between the wage model formulated at the aggregate level and those postulated for the individual industries is that for the latter we include a variable which incorporates inter-industry influences or "spillovers".[2] This has been described in two alternative forms, giving rise to the following two general industry equations (in the case where the labor market demand is measured by U_t^{-1}):

$$\dot{W}_{it} = b_0 + b_1(U_t^{-1})^* + b_2U_t^{-1} + b_3\pi_{it}^* + b_4\dot{P}_t^* + b_5\dot{P}_t + b_6(\dot{W}us_{it})^* + b_7(W_i/W_T)_t^* + b_8(W_i/W_T)_{t-1} \quad (3)$$

$$\dot{W}_{it} = b_0 + b_1(U_t^{-1})^* + b_2U_t^{-1} + b_3\pi_{it}^* + b_4\dot{P}_t^* + b_5\dot{P}_t + b_6(\dot{W}us_{it})^* + b_7\dot{W}_T^* + b_8\dot{W}_T , \quad (4)$$

where the subscript i denotes the industry,

W_i/W_T = relative wage position of the industry relative to all manufacturing,

$\dot{W}_T$ = (as before) the percentage change in money wages in manufacturing as a whole.

Thus equation (3) asserts that the spillover is in relative terms, while in equation (4) an absolute spillover is assumed.

Equations (1) to (4), and their analogues with employment change as the labor market variable, are the most general equations that were formulated on the basis of the theory we have developed. These equations were originally estimated in the above form. However, since the current change in consumer

[1] If non-union wages are not tied perfectly to union wages, then b_2' will of course also reflect the effect of unemployment in the non-unionized sector.

[2] cf. Otto Eckstein and T. A. Wilson (1962), McGuire and Rapping (1968). For a previous application to Canadian data see Reuber (1970).

prices $\dot{P}_t$ usually proved to be insignificant we have omitted it from the general models tabulated.[3]

Based on these considerations, we have estimated three general models which incorporate three alternative specifications of inter-industry influences. These models are as follows:[4]

Model 1

$$\dot{W}_{it} = b_0 + b_1(U_t^{-1})^* + b_2U_t^{-1} + b_3\pi_{it}^* + b_4\dot{P}_t^* + b_5(\dot{W}us_{it})^* \\ + b_6(W_i/W_T)_{t-1} \qquad (5)$$

Model 2

$$\dot{W}_{it} = b_0 + b_1(U_t^{-1})^* + b_2U_t^{-1} + b_3\pi_{it}^* + b_4\dot{P}_t^* + b_5(\dot{W}us_{it})^* \\ + b_6(W_i/W_T)_{t-1} + b_7\dot{W}_T^* \qquad (6)$$

Model 3

$$\dot{W}_{it} = b_0 + b_1(U_t^{-1})^* + b_2U_t^{-1} + b_3\pi_{it}^* + b_4\dot{P}_t^* + b_5(\dot{W}us_{it})^* \\ + b_6(W_i/W_T)_{t-1} + b_7(W_i/W_T)_t^* \qquad (7)$$

Tables III through XIV present the results of estimating these three general models, together with the corresponding alternative models with $\dot{E}_{it}^*$, the percentage change in production worker employment for the relevant industry, replacing U_t^{-1} as the labor market demand variable. The first six tables present "international" equations which include the U.S. wage change as an explanatory variable; the last six tables report the equations obtained when the U.S. wage change is dropped, resulting in a purely "domestic" model of wage determination.

THE VARIABLES

In this section we briefly describe the variables used in the empirical estimation. Detailed descriptions of the series and their data sources are given in the Statistical Appendix.

The Percentage Change in Money Wages[5]

The wage rate used is measured by the average hourly earnings (AHE) of production workers in the industry and the all manufacturing level, respectively. These data are gross and not corrected for overtime. Unfortunately, there do not exist any straight-time earnings series for Canada as are available for the United States. At an early stage of the study an attempt was made to construct

[3] The fact that current prices are insignificant should not be interpreted to mean that non-unionized workers are necessarily insensitive to cost of living increases in their wage demands. These workers may be concerned with expected inflation and their price expectations may be reflected by a weighted average of past price changes which is reasonably approximated by the contract weighted price variable used. Furthermore, to the extent that the wages of non-unionized workers follow closely those set in collective bargaining agreements we should not expect current price changes to be important. (See equation (1')).

[4] Other combinations of the spillover variables were tried, but the ones we are presenting proved to be the most satisfactory.

[5] See Appendix. Section 2.

straight-time earnings series for Canada,[6] but the results obtained with these corrected series were inferior to those obtained when the gross earnings series were used. Accordingly, any further attempt to derive correction factors for overtime hours worked was abandoned.[7]

The percentage change in money wages was derived as follows. Successive quarterly observations of AHE were averaged to yield observations centered at the end of each quarter and hence represent "within period" changes. Percentage changes of those resulting series expressed at annual rates were then used as the dependent variable. This involves some smoothing of the dependent variable, but because of the quality of the data, this is appropriate.[8] Average hourly earnings are reported only to the nearest cent, so that the observational errors contained in the data when such smoothing is not done is very serious. If, for example, the raw data indicate that over a quarter AHE increased by three cents from $1.50 to $1.53 (an increase of eight per cent per annum) because of rounding errors, this change could in fact be anywhere between two and four cents (or an annual per annum increase ranging from about five per cent to over 10 per cent). This is a substantial margin of observational error, and our definition of the dependent variable reduces it substantially.

Unemployment Rate[9]

These are aggregate unemployment rates and their sources are discussed in the Appendix, Section 2.

Percentage Change in Production Worker Employment[10]

The alternative labor demand variable used is the percentage change in production worker employment in manufacturing for the manufacturing sector equations; at the industry level, the percentage change in that industry's production worker employment has been used.

Percentage Change in Consumer Prices[11]

The percentage change in the consumer price index over the quarter extending from (t–l, t) was obtained as,

$$\dot{P}_t = \frac{\bar{P}_t - \bar{P}_{t-1}}{\bar{P}_{t-1}}$$

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[6] These correction factors were based on an analysis, using annual data for the manufacturing sector, of the relationship between avarage gross hourly earnings, average weekly hours, and the index of wage rates published by the Department of Labour. The correction factors obtained were very similar to those used in the U.S. by the Bureau of Labor Statistics. A straight-time earning series for manufacturing was derived from the gross average hourly earning series using average weekly hours and these correction factors.

[7] Since it proved impossible to derive meaningful correction factors for each major group within manufacturing, we decided not to pursue this line of research.

[8] Alternative equations at the manufacturing level indicate that the residuals were negative serially correlated where unsmoothed data were used, indicating that some smoothing would be appropriate.

[9] See Appendix, Section 2.

[10] See Appendix, Section 2.

[11] See Appendix, Section 3.

where $\overline{P}_t$ is a two monthly average of the monthly observations of the CPI, centered about the point, t. The reason for using two-month averages was in order to center the data about the end of the month, thereby enabling us to obtain within period percentage changes, which were then converted to annual rates.

Rate of Profit[12]

This is measured by after-tax cash flow defined as the sum of after-tax profits and depreciation for a given quarter divided by stockholders' equity for that same quarter. The resulting figure is expressed as a percentage at quarterly rates.

Percentage Change in U.S. Money Wages

These are measured by the percentage change in straight time average hourly earnings of production workers in the corresponding industry or sector in the U.S. expressed at annual rates. A detailed description of those data is given in chapter six.

Contract Weights

These represent the fraction of workers under collective bargaining agreements in period t whose contracts were signed in period $t - \tau$. These weights are described in detail in the Appendix, Section 9.

EMPIRICAL RESULTS

All equations were estimated using ordinary least squares. Since adequate contract data are only available over the period 1956-68, this period has accordingly been chosen as the basic sample period for our regression analysis.

All Manufacturing

The results for all manufacturing are presented in Tables I and II, which report equations using our contract-weighted model and a sample of standard models, respectively. In these tables, as throughout all the empirical chapters, we use the usual conventions for the descriptive statistics. $\bar{R}^2$ denotes the coefficient of determination corrected for degrees of freedom; D.W. is the Durbin-Watson statistic; S.E. is the standard error of estimate. The numbers in brackets under coefficients are their t-ratios. Referring first to Table I, equation (i) is the basic model using the contract weighted data and corresponds to equation (1). Note that $\dot{P}_t$ and $\dot{W}us_t$ are omitted; these were originally included but constantly proved to be insignificant and were accordingly dropped.

From a statistical point of view, this equation is extremely satisfactory. The $\bar{R}^2$ is high, all variables have t-ratios in excess of 2, and the D.W. statistic indi-

[12] See Appendix, Section 5. It should be noted that for seven industries, profit rates for three larger groupings were used. Profits for metal products and transportation equipment together were used in the equation for each; textiles and apparel, and tobacco, leather and miscellaneous were similarly grouped.

cates that autocorrelation at worst is very mild. Nevertheless, there are two puzzling aspects to this equation. First, the coefficient on the price change is greater than unity. Second, and more important, since the sum of the coefficients on U_t^{-1} and $(U_t^{-1})^*$ is negative, unemployment apparently has a *positive* impact on negotiated wage increases.

Price effects greater than unity are of course not impossible when workers are subject to progressive income taxes. For, if the average tax rate is denoted by a, and the marginal rate by m, then in order to be fully compensated for a $\dot{P}$ per cent increase in prices, the worker would require a $\frac{1-a}{1-m}\dot{P}$ per cent increase in money wages.[13] With progressive income taxes, $m > a$, implying a coefficient exceeding unity if the workers are to maintain their after-tax real income. Still, this could hardly account for a coefficient in the neighborhood of 1.8; moreover, to adequately test such hypotheses about the effects of income taxes requires that they be included explicitly into the analysis. Some initial attempts in this direction are reported in section four.

As for positive unemployment effects, these cannot be ruled out *a priori* for markets where trade unions play an important role. As we have discussed in chapter two, aggregate unemployment is likely to be an inappropriate measure of the effects of labor market conditions in a bilateral bargaining situation, in which case employment change will be a more appropriate measure. Given the fact that approximately 70 per cent of production workers in Canadian manufacturing are unionized, it is probable that the bilateral bargaining model may indeed be a more accurate description of the Canadian manufacturing labor market.

Hence, it is most important to look also at the analogous equation, where the percentage change of production worker employment is used instead of the rate of aggregate unemployment.[14] The statistical performance of equation (ii) is somewhat inferior to (i). The $\bar{R}^2$ drops to 0.65, with the t-ratios on π_t^* and $\dot{W}us_t^*$ also dropping below 2. However, in all other respects this equation is most satisfactory. Both $\dot{E}_t^*$ and $\dot{E}_t$ enter significantly with their predicted sign, and the coefficient of $\dot{P}_t^*$ is effectively unity.

Equations (iii) and (iv) in Table I are "domestic" versions of equations (i) and (ii), where the percentage change in U.S. wage rates are omitted. However, the fact that $(\dot{W}us)_t^*$ is both important in magnitude (the elasticities in the two equations being 0.52 and 0.43, respectively) and statistically significant in the two equations suggests that wage changes in the United States are an important determinant of Canadian wage movements for the manufacturing sector as a whole. One interesting feature of these results is that the inclusion of U.S. wage changes reduces the t-ratio and also lowers the impact of profit rates. This sug-

[13] This is discussed further in section four.

[14] We also did some experiments using the unemployment rate for employees in the manufacturing sector, but the results were the same as when the aggregate unemployment rate was used.

gests that in an open economy, ability to pay may depend as much on the wage behavior of foreign competition as upon the actual profit position of the domestic industry.

As an alternative approach to resolving the problem of the apparent positive relationship between unemployment and negotiated wage changes, equations (i) and (ii) were re-estimated constraining the sum of the coefficients of U_t^{-1} and $(U_t^{-1})^*$ to be equal to zero. This procedure assumes that the negotiated wage rates are unaffected by labor market conditions; the only effect that labor market conditions have is through wage drift.[15] As can be seen from equations (v) and (vi), the imposition of the constraint results in only a minor loss in explanatory power. The price coefficient is reduced somewhat in magnitude, but at the same time profits become insignificant in the international version of the model.

Thus, while models using the two alternative labor market variables yield substantially different results, nevertheless, several strong effects persist. Changes in the cost of living, profits (except in (v)), current labor-market conditions, and wage changes in the U.S. all have a strong positive impact on wages.

In order to provide a yardstick by which to compare these results with more traditional approaches, we have estimated the following "standard" model

$$\dot{W}_t = a_0 + a_1 U_t^{-1} + a_2 \pi_t + a_3 \dot{P}_t + a_4 \dot{W}us_t \tag{8}$$

the results of which are reported as equation (i) (international) and (ii) (domestic) in Table II. This equation relates current wage changes to current values of the explanatory variables. Lagged price changes were also included but proved to be insignificant. Many models (see e.g., Perry (1966), Bodkin *et al.* (1966)) relate four-quarter overlapping quarterly wage changes to a four-quarter moving average of the right-hand side of $\bar{R}^2$ (8). Such an equation is equivalent to an aggregation of (8) over four quarters, so that (8) is clearly a suitable standard model to serve as a comparison for our estimated equation.[16] Indeed, it would be inappropriate to test our models against any other arbitrary distributed lag models, since we could never be sure that the lags in such models are not in fact reflecting lags arising from the presence of multi-period contracts.

Equation (i) in Table II is substantially inferior to its contract weighted counterpart (i) of Table I. The value of $\bar{R}^2$ is now 0.62 while only two variables, price changes and U.S. wage changes have t-ratios greater than two. Even the unemployment rate is at best only "marginally" significant. Moreover, the importance of profits disappears altogether and this suggests that the standard equation (8) does indeed seriously misrepresent the bargaining process. Finally, the magnitudes of the various effects are quite different in (i); for example, the coefficients on price changes and U.S. wage changes both drop to about 0.31.

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[15] As remarked earlier this is strictly true only if non-union wages are tied directly to union wages.

[16] In order to compare this standard model with our contract-weighted models, it would be inappropriate to perform the aggregation over time in the manner just discussed, since the latter have not been so aggregated.

Much the same comments apply to the domestic version of the model, given in equation (ii), but the deterioration in results is even worse because U.S. wage changes are the most significant variable in this formulation.

Implications of The Results

While, in terms of *a priori* considerations, we would have a preference for the equation with the employment change variable as the labor market variable, the data cannot be said to have rejected alternative models. Despite the fact that the coefficients on some of the variables change greatly, the standard errors of estimate do not vary much between the models. Additional experiments in which the demand variables were dropped for the unionized sector yielded similarly fluctuating results—with the exception of the coefficient for the contract-weighted price changes, the coefficients of the other variables varied greatly, as did also their statistical significance, while the standard error of estimate changed hardly at all.

These results reflect, of course, the strong collinearity among the alternative independent variables. The variation in the data at this level of aggregation for this time period evidently is simply not rich enough to discriminate between some valid alternative hypotheses.

Despite the ambiguity of the results in certain respects, we feel that a number of tentative conclusions may nevertheless be drawn.

1. There appears to be a definite gain in utilizing the contract-weighted distributed lag model.
2. In contrast to the situation in the United States,[17] changes in the cost of living enter with a coefficient of almost unity in the preferred equation and greater than unity (although typically not significantly so) in the other equations. This confirms some earlier results of Turnovsky (1972), obtained using a different model.
3. While conclusion (2) above may be of comfort to those of neoclassical bent, we nevertheless should note that current price changes are insignificant, and equations which ignore the contract process yield coefficients well below unity for price changes over the 1956–68 period. These results are consistent with the view that wages of non-union workers (together with any wage drift) may be explained by a simple excess demand model and that it is for wage rates of union workers, which are negotiated for finite periods of time extending into the future, where consumer price changes become important.[18]
4. In no formulation is there a significant negative effect of unemployment on the bargaining process. To the extent that demand affects these negotiations, it is apparently the change in employment rather than the level

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[17]See, for example, the results presented in chapter six, see also Perry (1966, 1970) Gordon (1970, 1971), Turnovsky and Wachter (1972).

[18] The results are also consistent with the situation where wages of non-union workers are essentially determined by wages received by union workers, with the earnings of both influenced by wage drift.

of employment (or unemployment) that matters. None of the equations is therefore consistent with either the Phillips curve approach or with the accelerationist-natural unemployment rate approach to explaining such negotiated wage changes. On the other hand, current labor market conditions do appear to have a significant effect on current average hourly earnings, indicating that wage drift clearly is important.

5. Product market conditions—as reflected in rates of price increase and in profit rates—are at least as important and perhaps more important than labor market demand conditions *per se*.
6. U.S. wage changes are significant in both models and their coefficient is about 0.5. We should emphasize that this variable not only reflects possible union spillover effects, but also measures the improved competitive position of Canadian industry relative to U.S. industry which enables firms to pass on more readily any wage increases agreed upon.

Results Obtained from Extending the Standard Model to 1949–69

Since all data, other than the contract data, are available over the period 1949–69, in equation (iii) of Table II, we present the "best" standard model fitted to the entire period. This equation shows a striking improvement in comparison with the corresponding models given by equations (i) and (ii) when the richer data of the longer period are used. All variables except profit rates (omitted from the reported equation) become statistically significant over the longer period, whereas only current price changes and U.S. wage changes are significant over the shorter period. The insignificance of the profit rate variable over both periods is hardly surprising, since this variable cannot be expected to affect current non-negotiated wage changes and therefore, is most likely to be affected by the misspecification of the bargaining process which is inherent in such models. The results do suggest, however, that it would be well worthwhile to try to extend the contract analyses to include earlier and later years.

Industry Wage Equations

As was discussed in section one we have selected three general models specifying various forms of inter-industry influences. These have been used with the two alternative labor demand variables, and in each case we have an international and domestic version.[19]

Brief Synopsis of the Coefficients Obtained for the General Equations

We have estimated an extensive variety of models and in order to make the presentation of the results manageable, we have selected preferred general equations for each of the alternative labor market demand measures. These preferred equations are identified in Table XVI and are discussed further below. International models are selected in about half of the industries. The speci-

[19] Since there are no comparable data for U.S. miscellaneous, results for only the domestic version of this industry are given.

fication of the inter-industry influences (Models 1, 2, or 3 as the case may be) is also shown in this table.

Before proceeding to the preferred equations, we summarize briefly the implications of the results obtained from the various general models presented in Table III through XIV.

(a) *Inter-industry linkages.* These are clearly important as is shown by the strong performance of $(W_i/W_T)_{t-1}$. In only two industries does the evidence suggest the influence of this variable to be weak. There is no clear pattern, however, for the other two inter-industry variables. For the models with unemployment as the labor market demand variable, Model 1 is selected for four of the industries; Model 2 is selected for five, and Model 3 is chosen for the remaining six industries. Where the contract weighted relative wage is included, it typically has a positive sign, opposite to that of the current relative wage, suggesting that inter-industry spillovers affect wage drift.

(b) *Consumer Prices.* In contrast to the general insignificance of current changes in consumer prices $(\dot{P}_t)$ mentioned previously, the contract-weighted consumer price change variable $(\dot{P}_t^*)$ is typically statistically significant and quantitatively important. In six of the 15 industries it is positive with a t-ratio above two; in six other industries, it is positive with a t-ratio greater than one but less than two. Coefficients in several industries lie very close to unity; but in three industries the coefficients exceed unity by a substantial margin.

(c) *Profit Rates.* Profits are important in about half of the industries, and for the two largest and most important industries—food and beverages and metals—they are highly significant. This variable is also clearly important for the wood and leather industries and is of at least marginal significance for the textiles, rubber and apparel industries.

(d) *Rates of Increase of U.S. Wages.* This variable, which tests for the significance of international spillover effects, is important in slightly under half of the industries. Strongest results are again obtained for the important metals and food and beverages industries, but this variable is also statistically significant for textiles and is of marginal significance for the paper, printing, and transportation equipment industries.

(e) *Labor Market Demand Variables.* As we have already discussed, two alternative measures of labor market demand conditions were used. The first—the reciprocal of the unemployment rate—yielded coefficients which, while frequently significant, were of opposite signs for the current and contract-weighted variables (with the latter variable typically having a negative impact). As was pointed out earlier, where the sum of these effects is positive, these results are consistent with the hypothesis that demand conditions have a positive impact on negotiated rates, but with the deviation of current unemployment from unemployment at the time of negotiated agreement having an even stronger effect upon wage drift.

In several instances, however, the sum of these effects was negative. For these industries, the models were either abandoned in favor of models utilizing employment change, or else re-estimated with the sum of the coefficients on U_t^{-1} and $(U_t^{-1})^*$ constrained to be zero.[20]

For the wood, rubber, non-metallic products, and transportation equipment industries, employment change yielded superior results both in terms of goodness of fit and in terms of the significance and direction of effect of labor market demand. Both models perform about equally for the important metals industry.

For the tobacco industry, the use of employment change rather than the reciprocal of unemployment results in a marked improvement in goodness of fit, but the coefficient on current employment change is highly significantly negative. This reflects the fact—supported by other evidence[21]—that in this industry relatively low-paid workers are hired when employment expands, thereby causing earnings to drop.

Comparisons with Standard Models

In order to determine whether the general models presented above are superior to models which completely ignore the existence of contracts, we compare the goodness of fit (as measured by $\bar{R}^2$) of the above models which use the unemployment rate with a model in which wage changes depend only on the current values of the relevant variables.[22]

The results, presented in Table XV are striking. In not one instance is the standard model superior to the corresponding model utilizing contract weighting. The average improvement in the goodness of fit obtained by using the contract-weighted models is about one third.[23]

These results at the two-digit industry level therefore provide additional strong support for the use of contract-weighted distributed lag models in the analysis of wage behavior.

Preferred Models

A perusal of the results of the various general models already discussed reveals that in only two industries (metals and miscellaneous) are these models satisfactory as they stand. In some cases, as already noted, the results imply that the long-run impact of labor market demand conditions on earnings is negative. Negative coefficients appear frequently on profits and occasionally on consumer

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[20] As we have discussed, this constraint embodies the assumption that labor market demand conditions do not affect negotiated rates, but that change in employment over the life of the contract has a positive effect on wage drift.

[21] In connection with an attempt to develop estimates of straight-time earnings at the industry level, an analysis of the relationship between average hourly earnings, average weekly hours, the annual index of wage rates, and labor market conditions was carried out. The tobacco industry is the only industry where a statistically significant negative partial relationship between earnings and changes in employment was found.

[22] With the exception of consumer price changes, for which the lagged value is also included.

[23] Since our concern is with comparing the overall performance of our model with the standard, we do not bother to report the actual regression coefficients obtained for the latter.

prices. In some cases, the coefficient on consumer prices exceeds unity by a substantial margin.

To arrive at more satisfactory models, additional equations were estimated subject to constraints on the coefficients or with the omission of certain variables. These results are reported as the preferred wage equations in Table XVI.

Taken as a whole, these equations are most satisfactory. Typically over half of the variation in money wage changes is accounted for by the models, which must be regarded as good for equations predicting quarterly changes at the industry level.[24] More importantly, all of the variables included in the general model play an important role in a substantial number of industries.

While Table XVI presents an overview of all industries, it is important to remember that all industries are not of equal importance. The food and beverages industry and the metal products industry are particularly large, accounting between them for about 40 per cent of employment in manufacturing. It is therefore reassuring that the equations for these two important industries are of high quality.

Since all variables are important in a significant number of industries, these results suggest that we must adopt an eclectic view of the inflationary process within Canadian manufacturing. Such a finding is of course consistent with our aggregate equations. Clearly, the view that the behavior of labor markets in Canada can be regarded as the outcome of a simple supply-demand process must be rejected, since the importance of profits and U.S. wage changes cannot be readily incorporated into such a model.

While international spillover effects are significant in only six industries, where they are significant, the magnitude of the effect is large. Furthermore, they are important in our two largest industries, food and beverages and metals. Hence, we conclude that wage behavior in the U.S. plays an important although not predominant role in the determination of wages within Canadian manufacturing.

Profits appear in five industries, and are of clear statistical significance in only four. Once again, moreover, the important food and beverage and metal products industries are among those where profits play an important role. The importance of this variable indicates that product-market demand conditions tend to affect the labor market directly—a result in keeping with the theoretical analysis of wage bargaining developed in chapter two above.

The relative change in consumer prices is also an extremely important determinant of wage changes. Moreover, the coefficients are typically close to unity, which lends support to the accelerationists' view which emphasizes the role of inflationary expectations,[25] and provides confirmation at the two-digit industry level of the results obtained at the all manufacturing level.[26]

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[24]The relative changes are centered quarterly per cent changes, and are therefore smoothed. The goodness of fit of these equations compares favorably with those published by Reuber (1970), although Reuber's equations predict four-quarter overlapping absolute changes.

[25] See Friedman (1968), Phelps (1968).

[26] See also Turnovsky (1972).

Inter-industry linkages were clearly the most important variable (or set to variables) in the model, although the precise specification varies from model to model. Where the relative wage appears in contract-weighted form, it enters with a positive sign opposite to the simple lagged relative wage. As noted above, this may reflect the effect of relative wages upon wage drift, but it may also reflect the fact that a contract, once signed, will have cumulative effects on an industry's relative wage position over the life of the contract, since intra-industry spillovers across different contracts could be important.

The labor market demand variables are significant or marginally significant in virtually every equation. However, the pattern of coefficients suggests that, for many industries, the main impact of labor market demand conditions is upon wage drift rather than upon the contracted wage rates. This is the situation in printing, paper, textiles, apparel and food. However, in the important metals industry, and in wood, leather, rubber, petroleum and coal, non-metallic minerals and transportation equipment, labor market demand has a significant effect on contracted rates.

Where labor market demand affects the bargaining process directly, it is typically the employment change within the industry that matters (the only exception is leather). This perhaps accounts for the puzzling results we have obtained at the all manufacturing level, where the unemployment rate has a perverse sign, but has a higher $\overline{R}^2$ than equations with employment change.

While these results have policy implications which are described in general terms in chapter ten, we are not in a position to provide qualitative measures of the magnitude or timing of the effects of policy changes. This would require the development of a simulation model for this set of industries based on the wage equations presented here and the price and productivity equations presented in other chapters, together with the linking of such a simulation model to a macro-economic model of the economy as a whole.[27] However, there is one obvious implication of these models which should be emphasized: they indicate that simple "Phillips curve trade-off" types of calculations may be completely invalid and could be highly misleading.

Comparison with Previous Studies

We conclude this section with a brief comparison of our results with those obtained in previous studies of Canadian wage behavior.

At the all manufacturing level, wage determination has been extensively investigated by several researchers using different variants of what we have called the "standard model". Most of the earlier studies are summarized in

[27] The nature of the set of equations makes it impossible for us to derive partial or conditional calculations of policy trade-offs between unemployment and rates of inflation. This is because: (a) employment change rather than unemployment is the typical demand variable, and (b) inter-industry linkages necessitate a simulation approach to be used.

Bodkin, Bond, Reuber and Robinson (1966) who also estimate many of their own models. More recently several studies have been completed.[28]

Needless to say, these models differ from one another in such things as the exact specification, time period of estimation and frequency of observations, making any comparison with our study rather difficult. However, the overall conclusion emerging from the existing evidence is that labor market conditions, cost of living increases (or their expectations), profit rates and the rate of change of money wages in the United States all appear to play a significant role (at least at various periods, if not always) in explaining Canadian money wages. This agrees with the conclusion of our aggregate equation as well, although we do have the troublesome problem of the perverse sign on the contract-weighted unemployment variable, which we resolve by introducing a constraint.

The magnitudes of the coefficients estimated in these studies vary considerably for the different time periods. The question of the stability of the relationships has been discussed by Bodkin *et al.* For a more specific comparison of coefficients we shall focus on the study by Bodkin *et al.*, since it is based quarterly data over a sample period (1953–65) which most closely matches our own. They report equations estimated over this period in which the four factors we have analyzed (labor market demand, profits, consumer prices and U.S. wage changes), as well as lagged wage changes, enter statistically significantly.[29] Their implied long-run coefficient on U.S. wage changes is on the average about 0.40, which is in close agreement with our estimates. Their long-run price coefficient averages about 0.5 and is definitely lower than that reported here. A possible reason for the difference may be the fact that since their sample period stopped in 1965, it does not include the recent inflationary period during which workers may have become more sensitive to cost of living increases.[30] The Bodkin *et al.* equations all imply a stable long-run money wage-unemployment trade-off, whereas our models—whether we use employment change or the constrained unemployment variables—indicate a transitory effect of labor market conditions on wage changes. Finally, due to differences in definition, we cannot readily compare the magnitude of the profit effects in the two models.

The only comprehensive econometric wage study at the industry level within manufacturing previously carried out for Canada is the recent paper by Reuber (1970), which estimates equations using quarterly data over the period 1953–66. His model explains absolute wage changes, with labor market demand, profits, inter-industry and international spillovers, and lagged wage changes as independent variables. He does not include the percentage change in the CPI,

[28] Bodkin *et al.* (1966) summarize and update the earlier equations of Kaliski (1964), Klein and Bodkin (1964), Reuber (1964) and Vanderkamp (1966). More recent studies include Zaidi (1969), Turnovsky (1972) as well as the wage sector included in the TRACE (Choudhry *et al.* (1972)) and Bank of Canada (Helliwell *et al.* (1969)) econometric models.

[29] They use overlapping quarterly percentage changes in money wages as the dependent variable, so that any comparison of goodness of fit (they obtain $\overline{R}^2$ about 0.80) is meaningless.

[30] The study by Turnovsky (1972) which uses data through mid-1969 and obtains a price expectations coefficient of close to unity, would tend to confirm this conjecture.

arguing that price effects act through the spillover variable. The results of our analyses, however, suggest that this omission is open to question.

Reuber estimates equations for 12 two-digit industries, but because of differences in the availability of the required data his classification does not conform exactly to ours.[31] However, the overall picture provided by his results is in general agreement with that emerging from the present study, although there are differences as well. He finds that the domestic wage spillover variable is significant in eight industries and marginally significant in one other industry, making it the single most important variable. This too is one of the conclusions of our study where we found some form of spillover to be important in all industries.

Reuber finds unemployment to be significant in seven of his industries and marginally significant in an eighth. We find some form of labor market variable (more frequently employment change) to be significant in 10 industries, and marginally significant in another four, while it does not appear to influence wage behavior in the remaining industry—food and beverages. The industry pattern here seems to differ somewhat from his results; for example, while we find labor market conditions to be quite important determinants in the metals and transportation industry, Reuber finds the contrary, and vice versa in the case of food and beverages.

International effects are found to be statistically significant in three of Reuber's industries (paper, electrical apparatus, chemicals) and marginally important in a fourth (transportation equipment); we also obtain clear significance in three industries (printing and publishing, textiles, metals) and marginal significance in three others (transportation equipment, paper, food and beverages). While there is some agreement in the industries where international linkages appear to be important, there are some differences as well.

Finally, Reuber finds profits to be statistically important in three industries (transportation equipment, electrical apparatus, non-ferrous metals) and marginally significant in the food and beverages industry. We find profits entering statistically significantly in four industries (wood, metals, textiles, food and beverages) and marginally significantly in one other (miscellaneous). Since electrical apparatus and non-ferrous metals are component parts of the overall metals industry as we define it, these results are really quite similar.

To summarize, the results we have reported are in general agreement with the overall findings of Reuber's study, based on a "standard model".

However, as we have already commented, we regard the statistical quality of our set of preferred equations, judged in terms of the criteria of goodness of fit, to be superior to Reuber's results, confirming the advantages to be gained from using the contract-weighted approach.

[31] Nine of Reuber's 12 industries are identical to ours. He breaks down the metals industry into its three two-digit components. However, he does not consider several of the smaller two-digit industries such as wood, printing and publishing, leather, tobacco.

SOME EVIDENCE ON THE IMPACT OF DIRECT TAXES ON WAGE DETERMINATION

So far our theoretical and empirical analysis has ignored any considerations of the role of income taxes upon wage behavior. While we have not been able to investigate this question in the detail that it deserves, we have incorporated taxes into several models of wage determination estimated at the all manufacturing level. These results, while clearly preliminary, are of some interest and are reported below.

Role of Direct Taxes in the Wage Equation

Without attempting to formulate a rigorous theoretical model of how the income tax structure may affect wage behavior, it is clear that it will have three basic effects.

First, the existence of a progressive rate structure may affect the response of wages to other variables included in the model. This is so because a given before-tax relative change in money wages is translated into an after-tax relative change by the factor $(1 - m)/(1 - a)$, where m and a are the marginal and average rates of tax on wage income. The second effect through which taxes may influence wages is through shifts in the tax structure itself. The final possible avenue of influence is the direct effect on wages of the level of taxes.

To consider the first effect more carefully, suppose that the money wage is W, prices are P and the tax structure, assumed for the moment to be constant over time is denoted by T(W). Thus after-tax real wages are given by,

$$\frac{W - T(W)}{P}.$$

Assume that the percentage change in prices is $\dot{P}$. Then in order to maintain real wages constant the worker requires money wages to be increased sufficiently to ensure that,

$$\frac{d}{dt}\left(\frac{W - T(W)}{P}\right) = 0.$$

Carrying out the differentiation we obtain,

$$\dot{W} = \left(\frac{1 - a}{1 - m}\right) \dot{P},$$

where the marginal tax rate $m = T'(W)$

the average tax rate $a = T(W)/W$.

Thus, in a perfectly competitive model of the labor market, the existence of a progressive tax structure requires an adjustment to be made to the price variable. However, in the theoretical analysis of chapter two we have implicitly rejected such a model for the highly unionized sector of the labor market in favor of a bargaining model. With the bargaining model, the effects of tax variables upon the other explanatory variables must be assessed on an individual basis. The

strongest case for adjustment is that of the price change coefficient, since the rate of money wage increase which maintains a given real wage level in the face of price inflation will depend upon the tax structure. Since the unemployment rate variables measure the effect of labor market disequilibrium, the rationale for adjusting this variable for the tax structure is unclear.

In view of these considerations, we adjusted only the price change in the experiments reported in Table XVII, and also examined models in which all variables except the unemployment rate were also adjusted for tax rates. The latter are reported in Table XVIII.

As noted above, in addition to their impact on the wage response to changes in consumer prices, taxes may affect wages more directly through shifts in the tax structure itself. In terms of the above notation, the tax function may be of the form T(W,t) where t denotes time, so that even if wages remain constant there will be changes in taxes due to changes in the statutory rates. These shifts in the tax structure may have different effects upon wages depending upon the structure of the labor market.

In the context of the conventional supply-demand model of the labor market, changes in direct taxes will affect wages through their effects upon the supply of labor. In such a model, increases in *average* tax rates will exert upward pressure on wages unless the intersection of the supply and demand for labor is on the backward bending portion of the labor supply function. Furthermore, if the marginal tax rate rises, relative to the average rate, the supply of labor must necessarily contract, leading to an increase in wages.

Some might argue that the pressure of demand on supply is measured directly by the labor market demand variables and hence, that tax effects working through the shifts in the labor supply function should in principle be captured by these variables. However, this argument, if carried to its logical conclusion, would imply that unemployment rates would be the unique variable determining wage changes. The inclusion of tax variables—like the inclusion of other variables which affect the demand or supply of labor—is of course consistent with a wage adjustment mechanism in which wage changes respond directly to shifts in the demand and supply functions themselves, as well as to any existing labor market disequilibrium.

Since most workers in manufacturing are covered under collective bargaining agreements, the applicability of such a supply-demand analysis is necessarily very limited. Within the context of collective bargaining, two approaches are possible. First, in the context of a conventional union-as-a-monopoly model, direct taxes may be shown to affect the wage target of the union. This would imply that changes in wages would be related to *changes* in direct tax rates.

The second approach is based on an extension of the theoretical work of Pitchford,[32] who developed an analysis of cost inflation based on the concept of desired income shares. The extension of Pitchford's model to include tax shares implies that wage changes should respond to the *level* of taxes in relation

32 See Pitchford (1963).

to income—an effect analogous to that of profits. In both cases the *level* of the relevant variable would affect the rate of change of wages.

It is obvious, of course, that these alternative formulations have radically different implications. The conventional models suggest that an increase in the tax rate would exert temporary upward pressure on wages; the target shares model implies that an increase in tax rates would give rise to permanent upward pressure on wages.

To summarize the above discussion, we see that in order to incorporate the effects of taxes on wage determination, we must make two kinds of change to our model.

1. We must adjust the price variable and possibly other variables as well by the factor $(1 - a)/(1 - m)$.
2. We must include some additional variables which measure either changes in the tax structure or the level of the tax structure (or both).

Results

The results of incorporating alternative tax variables into models of wage determination at the all manufacturing level are reported in Tables XVII and XVIII. In these equations we have introduced four different variables reflecting the tax structure and its change, as well as the adjustment to the rate of change of prices and other variables. The relevant new notation is as follows:

a is the average tax rate,

m is the marginal tax rate,

a_x is the average tax rate with the tax structure of the current quarter and the income of the previous quarter,

m_x is the marginal tax rate with the tax structure of the current quarter and the income of the previous quarter,

$V=(1 - a)/(1 - m)$ is the scaling factor used to adjust coefficients on the independent variables.

With these definitions we construct the following tax variables:

$\dfrac{a}{1 - a}$ = average tax rate divided by the ratio of disposable income to total income, and is a measure of the tax burden expressed as a proportion of after-tax income,

$\dfrac{m}{1 - m}$ = is defined analogously and serves as a measure of the marginal tax burden,

$\dfrac{a_x - a_{-1}}{1 - a_{-1}}$ = change in the average tax rate calculated on the basis of the income of the previous year divided by the ratio of disposable income to total income in the previous year,

$$\frac{m_x - m_{-1}}{1 - m_{-1}} = \text{is analogously defined.}^{33}$$

The last two variables measure the effects of changes in the tax structure. Where followed by * the tax variables have been contract weighted.

When all four tax rate variables are introduced into the general wage equation, the collinearity among the large set of variables in the equations eliminates the statistical significance of most of the cœfficients in the model, so we focus our attention only on models with only one or two tax variables introduced.

Virtually all of the equations estimated are consistent with the view that the level of taxation—whether measured by the average rate of tax or by the marginal rate of tax or both—has a significant positive effect on rates of increase in wages. This result—if valid—has some very important policy implications.

The effects of changes in tax rates—while weaker—nevertheless are consistent across the different models. Where changes in average tax rates are introduced, they have a negative impact on wage increases; changes in marginal tax rates by contrast have a persistent positive impact on wage rates.

These results, while perhaps puzzling at first glance, may be resolved in terms of a combination of the conventional analysis of the effects of taxation upon the supply of labor combined with the operation of a target share model of wage determination. A negative impact of changes in the average tax rate can of course be readily demonstrated to be consistent with the conventional derivation of the supply curve of labor. The negative impact of the increase in average rates can arise if the intersection of supply and demand is in the backward bending portion of the supply schedule. This means that changes in the average tax rate induce workers to offer more labor for sale in an attempt to maintain after tax income. The resulting increase in the supply of labor will tend to dampen wage increases. Increases in the marginal rate will tend to have the opposite effect—workers will tend to substitute leisure for goods in order to avoid the increase in the marginal rate. The resulting reduction in the supply of labor will tend to stimulate wage increases.

The strong effect of the *level* of tax rates upon wage increases is only explicable within the context of a conventional supply-demand model of the labor market if the long-run effects of average tax rates upon labor supply are opposite to their short-run effect, and if the complete adjustment of the supply of labor to changes in taxes takes a long time. For example, if increased tax rates encourage emigration and discourage immigration[34] the longer-run effects of increases in

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[33] The variables $\frac{m_x - m_{-1}}{1 - m_{-1}}$ and $\frac{a_x - a_{-1}}{1 - a_{-1}}$ were constructed in order to eliminate the minor spurious association between increases in wage rates and changes in average and marginal tax rates under a progressive income tax structure.

[34] c.f. Wilson and Lithwick (1968).

average tax rates may be positive. This argument can be extended to include the effects of taxes upon inter-regional labor migration—since high tax rates reduce the incentive for workers to move from low to high wage regions—and to their effect upon labor mobility more generally—high tax rates reduce incentives for workers to move from low to high wage occupations or from low to high wage industries.

However, for an equation determining the wages of production workers—who are largely unionized—the possible role of target income shares in the bargaining process provides an alternative explanation for the importance of average tax rates. As was originally demonstrated by Pitchford, the conflicts between desired or target income shares of labor on the one hand and management on the other can be the source of a wage-price spiral in the absence of excess demand. Pitchford's theory is consistent with the introduction of the level of profit rates into an equation predicting the rate of change of wages. If Pitchford's analysis is extended to include the government as a third party in the struggle for income shares, the wage behavior of trade unions will be affected by the share of the government as represented by the level of direct taxes upon labor income.

While the tax variables—particularly the levels—are statistically significant and result in an overall improvement in the explanatory power of the wage equations, it is rather disturbing to observe the degree to which they introduce instability into the other coefficients. For example, adding the change in the average tax rate leaves the coefficient of price changes virtually unchanged at about 1.21. However, as soon as the average tax rate is introduced as well (see equation (5)), the coefficient drops to 0.02 and furthermore, the t ratio drops from over 5 down to .05. The coefficient for U.S. wage changes is similarly very sensitive. For example, ignoring taxes we obtained a coefficient of about 0.4 on $(\dot{W}us)^*$; introducing the change and level of average tax rates makes this coefficient increase to the improbable value of 0.79. On the other hand, when the analogous variables are defined in terms of marginal tax rates the U.S. wage coefficient drops to about zero.

While these results are interesting, they can hardly be viewed as definitive. Multi-collinearity among the large number of variables in the models which incorporate taxes, and the resulting instability in the estimated coefficients make it hazardous to draw firm conclusions or to select a particular equation for the manufacturing sector. The results do clearly suggest, however, that direct taxes appear to play an important role in the determination of money wages, and that the influence of this much overlooked factor warrants further research.[35]

[35] What is clearly required at the outset is an examination of the effects of taxes upon wage behavior at the industry level. Unfortunately, time and resource limitations did not permit us to carry out such an analysis.

TABLE I

All Manufacturing Wage Equations: Contract Model 1956–68

Equation	C	U_t^{-1}	$(U_t^{-1})^*$	$(U_t^{-1} - (U_t^{-1})^*)$	$\dot{E}_t$	$\dot{E}_t^*$	π_t^*	$\dot{P}_t^*$	$(\dot{W}us_t)^*$	$\bar{R}^2$	D.W.	S.E.
(i)	−7.508	30.765	−56.103				2.738	1.786	0.522	0.759	1.50	0.93
	[−2.40]	[6.38]	[−4.71]				[2.31]	[7.09]	[2.74]			
(ii)	−4.464				0.079	0.265	1.000	1.058	0.432	0.648	1.38	1.12
	[−1.98]				[2.19]	[2.64]	[1.30]	[4.59]	[1.36]			
(iii)	−9.336	22.538	−45.977				3.602	1.621		0.726	1.31	0.99
	[−2.87]	[5.58]	[−3.87]				[2.95]	[6.21]				
(iv)	−6.000				0.077	0.155	1.832	1.013		0.635	1.21	1.14
	[−2.86]				[2.08]	[2.01]	[3.34]	[4.34]				
(v)	−1.818			31.632			0.389	1.473	0.496	0.738	1.37	0.97
	[−0.93]			[6.298]			[0.64]	[6.70]	[2.51]			
(vi)	−3.952			23.722			1.374	1.337		0.709	1.21	1.02
	[−2.14]			[5.765]			[2.83]	[5.95]				

TABLE II

All Manufacturing Wage Equations: Standard Model

Equation	Estimation Period	C	U_t^{-1}	π_t	$\dot{P}_t$	$\dot{P}_{t-1}$	$(\dot{W}us)_t$	$\bar{R}^2$	D.W.	S.E.
(i)	1956–68	−1.973	11.270	0.551	0.314		0.319	0.618	1.54	1.17
		[−0.86]	[1.70]	[0.71]	[2.95]		[3.57]			
(ii)	1956–68	−2.342	14.285	0.784	0.286			0.524	0.96	1.32
		[−0.92]	[1.95]	[0.91]	[2.42]					
(iii)	1949–69	−0.574	13.596		0.320	0.384	0.202	0.805	1.43	1.34
		[−1.09]	[6.13]		[4.87]	[5.82]	[3.04]			

TABLE III

General Wage Equations for Production Workers:
International Model; Inter-Industry Model Type 1; Labor Market Demand: Reciprocal of Unemployment
1956–68

Industry	C	U_t^{-1}	$(U_t^{-1})^*$	$\dot{P}_t^*$	$(W_i/W_T)_{t-1}$	π^*_{it}	$(\dot{W}us_{it})^*$	$\bar{R}^2$	D.W.	S.E.
01 Food & Beverages	60.28	10.86	−30.66	2.065	−83.67	3.739	0.889	0.662	1.16	1.40
	[2.07]	[1.44]	[−2.14]	[4.52]	[−2.53]	[3.08]	[3.22]			
02 Tobacco	86.28	108.92	−210.55	9.689	−88.65	3.286	−0.202	0.206	1.71	5.73
	[3.39]	[3.37]	[−3.56]	[3.64]	[−3.74]	[1.02]	[−0.56]			
03 Rubber	183.38	34.01	−6.61	−0.204	−179.62	0.069	0.119	0.598	0.85	2.29
	[5.49]	[3.58]	[−0.38]	[−0.27]	[−5.49]	[1.56]	[0.71]			
04 Leather	140.42	33.91	0.47	1.291	−210.64	−0.630	0.159	0.735	2.12	1.21
	[6.15]	[6.11]	[0.04]	[2.62]	[−6.10]	[−0.67]	[0.55]			
05 Textiles	23.60	23.67	−24.68	1.222	−32.73	0.515	0.564	0.713	1.55	1.16
	[0.98]	[3.20]	[−2.34]	[2.45]	[−0.98]	[1.22]	[3.10]			
06 Apparel	−5.22	29.00	38.41	2.185	11.35	0.019	0.009	0.583	1.13	1.37
	[−0.16]	[3.18]	[3.25]	[4.22]	[0.22]	[0.04]	[0.05]			
07 Wood	119.24	10.29	7.30	2.275	−143.15	1.307	−0.544	0.470	1.28	2.46
	[3.97]	[0.70]	[0.29]	[2.31]	[−4.12]	[2.05]	[−1.64]			
08 Paper	71.06	43.70	−39.16	1.457	−59.44	−0.576	0.585	0.456	0.879	1.81
	[2.59]	[4.94]	[−1.39]	[1.68]	[−2.56]	[−0.44]	[1.64]			
09 Printing & Publishing	107.19	24.54	−40.95	0.920	−83.38	−0.106	0.194	0.571	1.50	1.06
	[3.91]	[3.39]	[−2.53]	[2.15]	[−3.88]	[−0.16]	[0.62]			
10 Metals	39.80	15.84	−20.28	0.364	−42.68	2.200	0.788	0.692	1.79	1.21
	[2.03]	[2.03]	[−1.52]	[0.70]	[−2.49]	[2.35]	[3.37]			
11 Transportation	102.63	42.47	−46.36	2.374	−80.50	−1.568	0.250	0.242	1.59	2.73
	[3.04]	[2.52]	[−1.06]	[2.66]	[−2.85]	[−0.65]	[1.08]			
14 Non-Metallic Minerals	−21.98	7.74	−0.66	1.054	24.58	−0.617	0.377	0.593	1.05	1.22
	[−0.86]	[1.01]	[−0.04]	[1.70]	[1.00]	[−0.97]	[1.29]			
15 Petroleum & Coal	143.42	24.75	−33.25	1.821	−99.16	−0.423	0.016	0.327	1.21	2.63
	[3.86]	[2.23]	[−1.00]	[1.86]	[−3.90]	[−0.44]	[0.10]			
16 Chemicals	120.40	1.45	−17.45	0.915	−100.97	−0.513	−0.358	0.652	0.105	1.22
	[5.60]	[0.21]	[−1.45]	[2.28]	[−5.72]	[−0.78]	[−1.40]			

Table IV

General Wage Equations for Production Workers:
International Model; Inter-Industry Model Type 2: Labor Market Demand: Reciprocal of Unemployment
1956–68

	Industry	C	U_t^{-1}	$(U_t^{-1})^*$	$\dot{P}_t^*$	$(W_i/W_T)_{t-1}$	$\dot{W}_t^*$	$\pi_i^*{}_t$	$(\dot{W}us_{it})^*$	$\overline{R}^2$	D.W.	S.E.
01	Food & Beverages	99.62	9.22	−45.82	1.393	−126.53	0.978	3.585	0.688	0.680	1.08	1.37
		[2.80]	[1.26]	[−2.83]	[2.42]	[−3.18]	[1.84]	[3.02]	[2.37]			
02	Tobacco	86.39	109.18	−211.84	9.656	−88.65	0.074	3.248	−0.208	0.188	1.71	5.79
		[3.34]	[3.28]	[−3.14]	[3.44]	[−3.69]	[0.04]	[0.96]	[−0.53]			
03	Rubber	187.13	35.04	−11.98	−0.361	−183.43	0.332	0.055	0.114	0.590	0.85	2.32
		[5.32]	[3.52]	[−0.53]	[−0.42]	[−5.31]	[0.37]	[0.94]	[0.67]			
04	Leather	137.51	35.21	−7.54	1.030	−206.43	0.447	−0.606	0.114	0.740	2.16	1.20
		[6.05]	[6.31]	[−0.60]	[1.96]	[−6.00]	[1.34]	[−0.65]	[0.40]			
05	Textiles	21.73	23.56	−23.30	1.275	−29.87	−0.126	0.458	0.589	0.707	1.57	1.18
		[0.85]	[3.15]	[−1.94]	[2.34]	[−0.84]	[−0.25]	[0.95]	[2.81]			
06	Apparel	−7.91	25.28	−43.56	1.080	12.71	1.036	0.389	−0.038	0.636	1.22	1.28
		[−0.26]	[2.93]	[−3.88]	[1.72]	[0.26]	[2.73]	[0.94]	[−0.23]			
07	Wood	127.21	13.71	−8.05	1.053	−154.36	1.590	1.346	−0.733	0.522	1.41	2.33
		[4.43]	[0.98]	[−0.33]	[0.99]	[−4.63]	[2.42]	[2.22]	[−2.26]			
08	Paper	64.56	42.72	−49.69	1.178	−55.25	0.549	−0.042	0.471	0.454	0.903	1.82
		[2.27]	[4.79]	[−1.63]	[1.28]	[−2.33]	[0.91]	[−0.03]	[1.25]			
09	Printing & Publishing	135.46	28.62	−35.81	1.130	−104.95	−0.580	−0.555	0.319	0.572	1.57	1.05
		[3.53]	[3.49]	[−2.12]	[2.40]	[−3.54]	[−1.05]	[−0.70]	[0.95]			
10	Metals	43.57	14.77	−16.24	−0.292	−44.12	0.672	1.298	0.716	0.704	1.80	1.19
		[2.25]	[1.93]	[−1.22]	[−0.46]	[−2.62]	[1.67]	[1.22]	[3.07]			
11	Transportation	102.79	42.92	−46.83	2.431	−80.74	−0.058	−1.514	0.262	0.225	1.59	2.76
		[2.99]	[2.16]	[−1.03]	[1.54]	[−2.77]	[−0.04]	[−0.74]	[0.74]			
14	Non-Metallic Minerals	−20.84	9.07	−4.10	0.744	22.80	0.379	−0.521	0.242	0.594	1.06	1.22
		[−0.82]	[1.17]	[−0.23]	[1.08]	[0.92]	[1.03]	[−0.81]	[0.76]			
15	Petroleum & Coal	142.89	25.06	−33.10	1.537	−98.90	0.253	−0.532	−0.004	0.314	1.20	2.65
		[3.80]	[2.23]	[−0.99]	[1.14]	[−3.85]	[0.32]	[−0.51]	[−0.02]			
16	Chemicals	125.04	1.16	−17.44	1.039	−105.24	−0.149	−0.420	−0.333	0.645	1.06	1.24
		[4.48]	[0.16]	[−1.44]	[1.67]	[−4.39]	[−0.27]	[−0.56]	[−1.21]			

TABLE V

General Wage Equations for Production Workers:
International Model; Inter-Industry Model Type 3; Labor Market Demand: Reciprocal of Unemployment
1956–68

	Industry	C	U_t^{-1}	$(U_t^{-1})^*$	$\dot{P}_t^*$	$(W_i/W_T)_{t-1}$	$(W_i/W_T)_t^*$	π_{it}^*	$(Wus_{it})^*$	$\bar{R}^2$	D.W.	S.E.
01	Food & Beverages	74.95	10.59	−33.72	2.114	−75.68	−24.10	3.762	0.867	0.656	1.15	1.42
		[1.43]	[1.39]	[−1.98]	[4.38]	[−1.85]	[−0.34]	[3.06]	[3.02]			
02	Tobacco	35.33	39.89	−121.18	7.135	−190.75	165.24	1.160	−0.602	0.394	1.66	5.00
		[1.37]	[1.19]	[2.14]	[2.95]	[−5.68]	[3.87]	[0.40]	[−1.83]			
03	Rubber	179.69	35.50	−6.05	−0.172	−175.02	−1.69	0.072	0.149	0.606	0.82	2.27
		[5.42]	[3.76]	[−0.35]	[−0.23]	[−5.38]	[−1.37]	[1.64]	[0.84]			
04	Leather	100.06	31.69	−3.25	1.247	−243.85	95.96	−0.806	0.240	0.745	2.21	1.19
		[3.02]	[5.65]	[−0.29]	[2.58]	[−6.18]	[1.65]	[−0.87]	[0.83]			
05	Textiles	−37.22	26.10	−34.69	1.403	−130.67	182.04	0.174	0.466	0.752	1.54	1.08
		[−1.20]	[3.76]	[−3.32]	[3.00]	[−2.81]	[2.84]	[0.42]	[2.71]			
06	Apparel	−9.68	30.12	−46.17	2.386	−39.89	58.38	0.201	0.034	0.585	1.08	1.36
		[−0.30]	[3.29]	[−3.36]	[4.36]	[−0.58]	[1.10]	[0.45]	[0.19]			
07	Wood	52.20	3.58	16.29	1.776	−174.88	108.52	1.378	0.678	0.486	1.28	2.42
		[1.00]	[0.24]	[0.64]	[1.74]	[−4.39]	[1.55]	[2.18]	[2.01]			
08	Paper	161.19	47.85	−75.20	2.670	−9.17	−128.30	0.618	0.401	0.540	1.24	1.67
		[4.13]	[5.80]	[−2.64]	[2.99]	[−0.34]	[−3.03]	[0.49]	[1.21]			
09	Printing & Publishing	83.89	20.77	−34.68	0.527	−101.26	36.22	−0.070	0.547	0.573	1.46	1.05
		[2.39]	[2.58]	[−2.02]	[0.94]	[−3.72]	[1.07]	[−0.11]	[1.20]			
10	Metals	6.82	17.50	−31.44	0.661	−94.44	76.83	3.423	0.796	0.699	1.72	1.20
		[0.23]	[2.25]	[−2.06]	[1.20]	[−2.35]	[1.42]	[2.71]	[3.44]			
11	Transportation	64.79	36.31	−28.61	1.914	−83.23	35.79	−0.233	0.448	0.231	1.59	2.75
		[0.86]	[1.80]	[−0.53]	[1.58]	[−2.88]	[0.57]	[−0.84]	[1.07]			
14	Non-Metallic Minerals	−59.79	4.65	2.00	0.789	−6.75	67.35	−0.259	0.355	0.593	0.991	1.22
		[−1.31]	[0.56]	[0.11]	[1.17]	[−0.17]	[1.00]	[−0.35]	[1.21]			
15	Petroleum & Coal	111.55	20.51	−26.73	1.643	−120.19	42.94	−0.137	−0.040	0.330	1.36	2.62
		[2.35]	[1.75]	[−0.79]	[1.66]	[−3.76]	[1.08]	[−0.14]	[−0.24]			
16	Chemicals	120.34	1.00	−16.94	0.903	−105.17	4.39	−0.541	−0.358	0.644	1.05	1.24
		[5.32]	[0.13]	[−1.34]	[2.19]	[−3.21]	[0.15]	[−0.79]	[−1.38]			

TABLE VI

General Wage Equations for Production Workers:
International Model; Inter-Industry Model Type 1; Per Cent Change in Employment
1956–68

Industry	C	$\dot{E}^*_{it}$	$\dot{E}_{it}$	$\dot{P}^*_t$	$(W_i/W_T)_{t-1}$	π^*_{it}	$(\dot{W}us_{it})^*$	$\bar{R}^2$	D.W.	S.E.
01 Food & Beverages	33.81	−0.474	0.005	1.114	−51.48	3.623	0.340	0.650	1.07	1.43
	[1.59]	[−1.48]	[0.06]	[3.70]	[−2.26]	[3.12]	[1.24]			
02 Tobacco	23.03	−0.313	−0.044	1.964	−10.30	−3.071	0.090	0.748	1.62	3.22
	[1.47]	[−11.72]	[−0.39]	[2.50]	[−1.05]	[−0.91]	[0.49]			
03 Rubber	122.38	0.174	−0.083	0.690	−116.69	0.015	0.256	0.620	1.10	2.23
	[3.78]	[5.01]	[−1.49]	[1.42]	[−3.73]	[0.34]	[1.66]			
04 Leather	85.20	0.030	0.131	2.096	−140.16	3.326	−0.795	0.445	1.45	1.76
	[2.53]	[0.49]	[1.11]	[4.78]	[−2.81]	[2.91]	[−2.34]			
05 Textiles	15.69	0.055	−0.043	0.459	−24.82	1.305	0.622	0.668	1.40	1.26
	[0.59]	[1.76]	[−0.52]	[1.41]	[−0.67]	[3.34]	[2.95]			
06 Apparel	−36.55	−0.128	−0.148	0.169	54.38	1.578	0.079	0.530	0.97	1.45
	[−1.41]	[−2.39]	[−0.90]	[0.37]	[1.34]	[3.63]	[0.37]			
07 Wood	110.38	0.022	0.091	2.648	−129.77	0.971	−0.169	0.499	0.931	2.39
	[3.72]	[0.44]	[2.24]	[4.59]	[−3.75]	[2.00]	[−0.63]			
08 Paper	13.29	0.436	0.177	0.569	−11.46	−0.057	0.666	0.264	0.749	2.11
	[0.37]	[1.44]	[1.66]	[1.10]	[−0.38]	[−0.06]	[1.29]			
09 Printing & Publishing	42.05	0.115	0.058	0.268	−31.47	−0.623	0.851	0.503	1.49	1.14
	[2.24]	[1.13]	[0.85]	[0.93]	[−2.19]	[−1.68]	[2.94]			
10 Metals	29.97	0.063	0.140	0.705	−34.24	1.750	0.756	0.721	1.81	1.16
	[1.52]	[2.17]	[1.77]	[1.40]	[−2.00]	[3.17]	[3.00]			
11 Transportation	89.95	0.156	0.046	1.626	−72.45	−0.926	0.313	0.434	1.52	2.36
	[3.51]	[3.99]	[0.49]	[2.85]	[−3.56]	[−0.99]	[1.16]			
14 Non-Metallic Minerals	−15.64	0.106	−0.027	1.233	19.64	−0.759	0.485	0.610	1.14	1.20
	[−0.68]	[2.19]	[−0.91]	[4.88]	[0.90]	[−1.47]	[1.80]			
15 Petroleum & Coal	143.93	0.123	0.039	0.935	−97.72	−1.001	−0.084	0.340	1.26	2.60
	[4.11]	[1.93]	[0.65]	[2.02]	[−4.07]	[−1.62]	[−0.51]			
16 Chemicals	88.28	−0.040	0.053	0.545	−74.84	−0.372	−0.287	0.637	0.904	1.25
	[5.44]	[−0.35]	[1.24]	[2.13]	[−5.64]	[−0.53]	[−1.11]			

TABLE VII

General Wage Equations for Production Workers:
International Model; Inter-Industry Model Type 2: Per Cent Change in Employment
1956–68

Industry	C	$\dot{E}^*_{it}$	$\dot{E}_{it}$	$\dot{P}^*_t$	$(W_i/W_T)_{t-1}$	$\dot{W}^*_t$	π^*_{it}	$(\dot{W}us_{it})^*$	$\overline{R}^2$	D.W.	S.E.
01 Food & Beverages	33.98	−0.469	0.006	1.054	−51.51	0.057	3.598	0.319	0.642	1.07	1.45
	[1.58]	[−1.46]	[0.07]	[1.95]	[−2.23]	[0.14]	[2.87]	[1.00]			
02 Tobacco	25.23	−0.311	−0.055	2.448	−11.79	−0.343	−3.107	0.101	0.743	1.59	3.25
	[1.51]	[−11.35]	[−0.48]	[1.68]	[−1.11]	[−0.40]	[−0.92]	[0.54]			
03 Rubber	145.17	0.194	−0.045	−0.977	−142.68	1.732	−0.023	0.099	0.667	1.25	2.09
	[4.62]	[5.82]	[−0.84]	[−1.28]	[−4.63]	[2.71]	[−0.54]	[0.64]			
04 Leather	93.74	0.016	0.098	1.414	−152.85	0.490	3.107	−0.747	0.448	1.35	1.75
	[2.73]	[0.25]	[0.80]	[1.87]	[−2.99]	[1.10]	[2.68]	[−2.19]			
05 Textiles	18.93	0.069	−0.053	0.108	−31.16	0.439	1.505	0.507	0.668	1.37	1.26
	[0.71]	[2.02]	[−0.63]	[0.23]	[−0.83]	[1.02]	[3.44]	[2.12]			
06 Apparel	−25.95	−0.121	−0.275	−1.149	33.50	0.995	2.057	−0.034	0.579	1.11	1.37
	[−1.04]	[−2.39]	[−1.67]	[−1.69]	[0.85]	[2.49]	[4.53]	[−0.16]			
07 Wood	124.79	−0.057	0.094	0.281	−151.18	1.993	1.456	−0.683	0.570	1.06	2.21
	[4.47]	[−1.07]	[2.48]	[0.29]	[−4.60]	[2.90]	[3.04]	[−2.22]			
08 Paper	−7.98	0.497	0.195	−1.068	5.95	1.364	−0.345	0.454	0.330	1.03	2.01
	[−0.22]	[1.71]	[1.91]	[−1.24]	[0.20]	[2.32]	[−0.40]	[0.91]			
09 Printing & Publishing	54.10	0.136	0.082	0.578	−41.02	−0.384	−0.587	0.972	0.499	1.53	1.14
	[2.24]	[1.29]	[1.10]	[1.20]	[−2.19]	[−0.81]	[−1.57]	[2.97]			
10 Metals	33.55	0.060	0.109	0.203	−36.44	0.409	1.433	0.671	0.721	1.78	1.16
	[1.67]	[2.06]	[1.28]	[0.28]	[−2.11]	[0.98]	[2.23]	[2.51]			
11 Transportation	89.66	0.157	0.047	1.712	−72.42	−0.104	−0.823	0.334	0.422	1.52	2.38
	[3.43]	[3.84]	[0.49]	[1.68]	[−3.52]	[−0.10]	[−0.60]	[0.97]			
14 Non-Metallic Minerals	−14.92	0.114	−0.023	0.762	18.32	0.450	−0.739	0.316	0.615	1.12	1.19
	[−0.65]	[2.37]	[−0.78]	[1.69]	[0.84]	[1.26]	[−1.44]	[1.06]			
15 Petroleum & Coal	143.57	0.127	0.040	0.533	−97.57	0.362	−1.148	−0.116	0.328	1.25	2.62
	[4.06]	[1.95]	[0.65]	[0.53]	[−4.03]	[0.45]	[−1.64]	[−0.64]			
16 Chemicals	89.04	−0.041	0.053	0.571	−75.56	−0.030	−0.353	−0.281	0.629	0.902	1.26
	[4.07]	[−0.35]	[1.23]	[1.04]	[−3.95]	[−0.53]	[−0.44]	[−1.00]			

TABLE VIII

General Wage Equations for Production Workers:
International Model; Inter-Industry Model Type 3: Per Cent Change in Employment
1956–68

Industry	C	$\dot{E}^*_{it}$	$\dot{E}_{it}$	$\dot{P}^*_t$	$(W_i/W_T)_{t-1}$	$(W_i/W_T)^*_t$	π^*_{it}	$(\dot{W}us_{it})^*$	$\overline{R}^2$	D.W.	S.E.
01 Food & Beverages	15.58	−0.521	−0.004	1.167	−91.74	59.15	3.961	0.476	0.652	1.08	1.43
	[0.58]	[−1.64]	[−0.05]	[3.84]	[−2.13]	[1.10]	[3.30]	[1.16]			
02 Tobacco	14.92	−0.274	−0.060	2.148	−71.46	72.81	−3.603	−0.109	0.788	1.57	2.96
	[1.02]	[−9.95]	[−0.59]	[2.97]	[−3.27]	[3.07]	[−1.17]	[−0.61]			
03 Rubber	124.89	0.181	−0.097	0.581	−119.82	1.03	0.009	0.246	0.617	1.09	2.24
	[3.83]	[5.03]	[−1.66]	[1.14]	[−3.78]	[0.81]	[0.20]	[1.59]			
04 Leather	6.82	−0.016	0.138	1.556	−250.23	233.45	1.688	−0.239	0.542	1.41	1.60
	[0.18]	[−0.27]	[1.28]	[3.60]	[−4.42]	[3.23]	[1.46]	[−0.68]			
05 Textiles	−48.61	0.067	0.028	0.330	−133.70	196.43	0.876	0.574	0.716	1.58	1.16
	[−1.48]	[2.27]	[0.35]	[1.08]	[−2.66]	[2.94]	[2.25]	[2.93]			
06 Apparel	−36.71	−0.128	−0.142	0.180	59.34	−4.58	1.547	0.080	0.519	0.98	1.47
	[−1.40]	[−2.36]	[−0.79]	[0.38]	[0.87]	[−0.09]	[2.79]	[0.37]			
07 Wood	28.25	0.070	0.065	2.530	−116.11	130.80	0.791	−0.292	0.518	1.02	2.34
	[0.50]	[1.25]	[1.52]	[4.44]	[−4.12]	[1.67]	[1.62]	[−1.06]			
08 Paper	97.66	0.058	0.249	1.089	21.29	−105.25	0.497	−0.036	0.300	0.954	2.06
	[1.67]	[0.16]	[2.24]	[1.87]	[0.61]	[−1.80]	[0.54]	[−0.06]			
09 Printing & Publishing	19.70	0.102	0.031	−0.273	−77.26	63.25	−0.448	1.305	0.530	1.39	1.11
	[0.91]	[1.03]	[0.47]	[−0.68]	[−2.77]	[1.90]	[−1.20]	[3.53]			
10 Metals	6.19	0.070	0.134	0.835	−69.42	54.11	2.173	0.747	0.724	1.73	1.15
	[0.22]	[2.39]	[1.71]	[1.63]	[−2.07]	[1.22]	[3.35]	[2.97]			
11 Transportation	46.43	0.147	0.066	1.309	−85.54	48.87	−1.309	0.617	0.437	1.56	2.35
	[0.99]	[3.67]	[0.70]	[2.06]	[−3.64]	[1.11]	[−1.11]	[1.60]			
14 Non-Metallic Minerals	−22.71	0.099	−0.026	1.187	14.28	12.01	−0.676	0.477	0.601	1.13	1.21
	[−0.42]	[1.14]	[−0.81]	[2.92]	[0.33]	[0.14]	[−0.87]	[1.72]			
15 Petroleum & Coal	117.39	0.109	0.025	0.928	−115.10	35.35	−0.652	0.110	0.335	1.40	2.61
	[2.50]	[1.64]	[0.40]	[2.00]	[−3.65]	[0.85]	[−0.88]	[0.65]			
16 Chemicals	88.38	−0.047	0.067	0.545	−57.18	−18.44	−0.204	−0.304	0.632	0.915	1.26
	[5.40]	[−0.40]	[1.36]	[2.12]	[−1.74]	[−0.59]	[−0.27]	[−1.16]			

TABLE IX

General Wage Equation for Production Workers:
Domestic Model; Inter-Industry Model Type 1: Labor Market Demand: Reciprocal of Unemployment
1956–68

Industry	C	U_t^{-1}	$(U_t^{-1})^*$	$\dot{P}_t^*$	$(W_i/W_T)_{t-1}$	π_{it}^*	$\bar{R}^2$	D.W.	S.E.
01 Food & Beverages	32.15	1.61	−2.92	1.628	−43.40	1.985	0.594	0.951	1.54
	[1.05]	[0.21]	[−2.33]	[3.40]	[−1.29]	[1.67]			
02 Tobacco	86.22	104.33	−196.93	8.814	−88.25	2.901	0.218	1.70	5.68
	[3.42]	[3.36]	[−3.67]	[4.12]	[−3.75]	[0.93]			
03 Rubber	178.57	32.34	−1.59	−0.351	−175.19	0.084	0.603	0.83	2.29
	[5.50]	[3.54]	[−0.10]	[−0.49]	[−5.49]	[2.19]			
04 Leather	142.00	33.23	−1.81	1.443	−214.23	−0.199	0.739	2.13	1.20
	[6.32]	[6.19]	[−0.18]	[3.57]	[−6.36]	[−0.39]			
05 Textiles	−22.97	27.45	−27.63	1.668	32.78	−0.85	0.660	1.44	1.27
	[−1.11]	[3.45]	[−2.41]	[3.21]	[1.16]	[−0.21]			
06 Apparel	−5.65	29.03	−38.49	2.197	12.05	0.012	0.592	1.13	1.35
	[−0.18]	[3.22]	[−3.32]	[4.85]	[0.24]	[0.03]			
07 Wood	120.81	9.91	−5.92	2.161	−143.18	1.364	0.450	1.26	2.50
	[3.95]	[0.67]	[−0.25]	[2.16]	[−4.05]	[2.10]			
08 Paper	87.39	36.45	−19.15	1.278	−73.59	−0.801	0.436	0.814	1.85
	[3.36]	[4.67]	[−0.74]	[1.46]	[−3.27]	[−0.60]			
09 Printing & Publishing	118.23	26.95	−46.06	1.054	−91.97	−0.045	0.577	1.49	1.05
	[5.70]	[4.45]	[−3.33]	[2.87]	[−5.65]	[−0.07]			
10 Metals	12.68	7.67	−16.16	0.463	−19.30	3.032	0.623	1.38	1.34
	[0.64]	[0.94]	[−1.10]	[0.81]	[−1.11]	[3.03]			
11 Transportation	115.13	40.32	−53.70	2.620	−90.98	−1.073	0.240	1.53	2.74
	[3.62]	[2.40]	[−1.24]	[3.03]	[−3.42]	[−0.45]			
14 Non-Metallic Minerals	−29.51	8.06	3.24	1.140	30.30	−0.200	0.587	0.992	1.23
	[−1.18]	[1.05]	[0.18]	[1.63]	[1.24]	[−0.36]			
15 Petroleum & Coal	143.54	24.81	−32.79	1.812	−99.24	−0.435	0.342	1.21	2.60
	[3.91]	[2.26]	[−1.00]	[1.88]	[−3.95]	[−0.45]			
16 Chemicals	104.28	5.40	−21.18	0.995	−89.06	−0.164	0.645	1.02	1.24
	[5.67]	[0.84]	[−1.79]	[2.48]	[−5.70]	[−0.27]			
17 Miscellaneous	58.32	6.27	12.64	0.256	−71.53	0.166	0.623	1.08	1.24
	[2.09]	[0.87]	[1.13]	[0.47]	[−2.16]	[0.41]			

TABLE X

General Wage Equation for Production Workers:
Domestic Model; Inter-Industry Model Type 2; Labor Market Demand: Reciprocal of Unemployment
1956–68

Industry	C	U_t^{-1}	$(U_t^{-1})^*$	$\dot{P}_t^*$	$(W_i/W_T)_{t-1}$	$\dot{W}_t^*$	π_{it}^*	$\bar{R}^2$	D.W.	S.E.
01 Food & Beverages	99.89	2.34	−34.68	0.777	−120.44	1.450	2.343	0.647	0.903	1.44
	[2.68]	[0.33]	[−2.13]	[1.44]	[−2.89]	[2.81]	[2.10]			
02 Tobacco	85.79	103.84	−193.52	9.008	−88.29	−0.291	3.10	0.201	1.70	5.74
	[3.35]	[3.30]	[−3.37]	[3.56]	[−3.71]	[−0.18]	[0.92]			
03 Rubber	183.10	33.60	−7.97	−0.524	−179.77	0.379	0.068	0.595	0.83	2.30
	[5.32]	[3.48]	[−0.37]	[−0.63]	[−5.30]	[0.43]	[1.23]			
04 Leather	138.54	34.77	−9.44	1.129	−208.84	0.462	−0.300	0.745	2.16	1.19
	[6.20]	[6.41]	[−0.83]	[2.46]	[−6.23]	[1.41]	[−0.59]			
05 Textiles	−5.55	27.17	−33.10	1.350	7.26	0.550	0.285	0.662	1.38	1.27
	[−0.22]	[3.43]	[−2.69]	[2.31]	[0.20]	[1.17]	[0.55]			
06 Apparel	−6.06	25.19	−43.15	1.039	9.61	1.027	0.413	0.643	1.22	1.26
	[−0.21]	[2.95]	[−3.94]	[1.74]	[0.21]	[2.76]	[1.05]			
07 Wood	127.41	12.46	−21.40	1.181	−151.89	1.234	1.410	0.478	1.34	2.44
	[4.25]	[0.86]	[−0.86]	[1.07]	[−4.36]	[1.86]	[2.22]			
08 Paper	73.31	37.07	−40.14	0.922	−62.78	0.800	0.039	0.448	0.874	1.83
	[2.65]	[4.79]	[−1.35]	[1.02]	[−2.71]	[1.39]	[0.03]			
09 Printing & Publishing	142.27	30.78	−44.80	1.255	−110.39	−0.394	−0.323	0.573	1.54	1.05
	[4.32]	[0.58]	[−1.71]	[2.23]	[−4.27]	[−0.77]	[−0.43]			
10 Metals	21.08	7.25	−11.26	−0.429	−24.11	0.901	1.720	0.649	1.47	1.30
	[1.08]	[0.92]	[−0.78]	[−0.62]	[−1.43]	[2.09]	[1.49]			
11 Transportation	106.45	36.29	−44.23	1.825	−82.38	0.675	−1.967	0.233	1.55	2.75
	[3.15]	[2.06]	[−0.98]	[1.36]	[−2.85]	[0.75]	[−0.75]			
14 Non-Metallic Minerals	−24.50	9.63	−3.07	0.629	25.31	0.493	−0.270	0.598	1.05	1.22
	[−0.99]	[1.25]	[−0.17]	[0.94]	[1.04]	[1.48]	[−0.49]			
15 Petroleum & Coal	142.87	25.03	−33.22	1.548	−98.89	0.245	−0.526	0.329	1.20	2.62
	[3.85]	[2.26]	[−1.01]	[1.23]	[−3.90]	[0.33]	[−0.52]			
16 Chemicals	119.31	3.91	−20.47	1.304	−102.35	−0.385	0.013	0.641	1.02	1.24
	[4.32]	[0.58]	[−1.71]	[2.23]	[−4.27]	[−0.73]	[0.02]			
17 Miscellaneous	58.86	7.95	2.43	−0.095	−71.78	0.671	−0.083	0.645	1.17	1.21
	[2.17]	[1.12]	[0.21]	[−0.17]	[−2.24]	[1.95]	[−0.20]			

TABLE XI

General Wage Equation for Production Workers:
Domestic Model; Inter-Industry Model Type 3; Labor Market Demand: Reciprocal of Unemployment
1956–68

	Industry	C	U_t^{-1}	$(U_t^{-1})^*$	$\dot{P}^*$	$(W_i/W_T)_{t-1}$	$(W_i/W_T)^*_t$	π^*_{it}	$\bar{R}^2$	D.W.	S.E.
01	Food & Beverages	79.41	1.64	−14.50	1.810	−21.99	−74.05	2.191	0.594	0.955	1.54
		[1.39]	[0.22]	[−0.84]	[3.53]	[−0.55]	[−0.98]	[1.81]			
02	Tobacco	42.70	37.78	−97.77	5.159	−174.56	140.77	0.440	0.363	1.62	5.13
		[1.63]	[10.1]	[−1.73]	[2.33]	[−5.26]	[3.38]	[0.15]			
03	Rubber	174.09	33.33	0.08	−0.357	−169.96	−1.55	0.091	0.608	0.80	2.27
		[5.36]	[3.66]	[0.01]	[−0.50]	[−5.32]	[−1.27]	[2.35]			
04	Leather	105.85	30.85	−6.27	1.474	−246.26	86.79	−0.160	0.747	2.22	1.19
		[3.28]	[5.61]	[−0.60]	[3.69]	[−6.28]	[1.54]	[−0.32]			
05	Textiles	−85.78	29.56	−38.94	1.792	−97.26	216.67	−0.368	0.717	1.36	1.16
		[−3.17]	[4.06]	[−3.54]	[3.77]	[−2.03]	[3.22]	[−0.96]			
06	Apparel	−11.18	30.20	−46.32	2.427	−36.07	57.11	0.173	0.593	1.08	1.35
		[−0.36]	[3.34]	[−3.41]	[4.87]	[−0.55]	[1.10]	[0.41]			
07	Wood	76.23	5.36	−2.09	1.808	−164.40	72.56	1.421	0.451	1.23	2.50
		[1.45]	[0.35]	[−0.09]	[1.72]	[−4.03]	[1.04]	[2.18]			
08	Paper	178.56	43.34	−64.54	2.639	−14.24	−137.62	0.555	0.535	1.18	1.68
		[4.90]	[5.87]	[−2.37]	[2.95]	[−0.53]	[−3.28]	[0.44]			
09	Printing & Publishing	117.64	27.06	−46.60	1.026	−98.03	6.56	−0.019	0.568	1.48	1.06
		[5.58]	[4.41]	[−3.30]	[2.68]	[−3.60]	[0.28]	[−0.03]			
10	Metals	−18.53	9.15	−26.60	0.743	−67.64	72.10	4.188	0.627	1.29	1.34
		[−0.57]	[1.11]	[−1.56]	[1.21]	[−1.54]	[1.20]	[3.02]			
11	Transportation	131.02	44.79	−60.49	2.771	−84.71	−20.34	−0.860	0.228	1.57	2.75
		[3.11]	[2.41]	[−1.34]	[3.04]	[−2.93]	[−0.53]	[−0.36]			
14	Non-Metallic Minerals	−70.41	4.66	5.89	0.727	−4.38	73.73	0.165	0.589	0.921	1.23
		[−1.56]	[0.56]	[0.33]	[1.08]	[−0.11]	[1.09]	[0.26]			
15	Petroleum & Coal	113.44	20.66	−28.19	1.675	−118.60	40.04	−0.131	0.344	1.36	2.59
		[2.45]	[1.78]	[−0.86]	[1.72]	[−3.83]	[1.07]	[−0.13]			
16	Chemicals	104.25	4.85	−20.56	0.982	−94.12	5.24	−0.199	0.637	1.01	1.25
		[5.61]	[0.67]	[−1.65]	[2.38]	[−2.93]	[1.81]	[−0.31]			
17	Miscellaneous	−7.22	1.94	6.72	0.946	−115.01	122.12	0.417	0.665	1.34	1.17
		[−0.20]	[0.28]	[0.64]	[1.65]	[−3.25]	[2.60]	[1.05]			

TABLE XII

General Wage Equation for Production Workers:
Domestic Model; Inter-Industry Model Type 1; Labor Market Demand: Employment Change
1956–68

Industry	C	$\dot{E}^*_{it}$	$\dot{E}_{it}$	$\dot{P}^*_t$	$(W_i/W_T)_{t-1}$	π^*_{it}	$\bar{R}^2$	D.W.	S.E.
01 Food & Beverages	41.62	−0.690	0.047	1.237	−54.95	2.785	0.646	1.07	1.44
	[2.04]	[−2.60]	[0.62]	[4.32]	[−2.41]	[2.93]			
02 Tobacco	20.44	−0.314	−0.037	2.088	−8.59	−2.794	0.753	1.63	3.20
	[1.40]	[−11.92]	[−0.34]	[2.83]	[−0.95]	[−0.85]			
03 Rubber	109.62	0.165	−0.061	0.858	−104.26	0.047	0.606	0.94	2.27
	[3.42]	[4.73]	[−1.11]	[1.76]	[−3.36]	[1.19]			
04 Leather	46.38	0.020	0.198	1.871	−74.42	1.245	0.391	1.32	1.84
	[1.52]	[0.31]	[1.65]	[4.17]	[−1.72]	[1.65]			
05 Textiles	−37.91	0.073	−0.144	0.731	49.52	0.997	0.612	1.21	1.36
	[−1.82]	[2.20]	[−1.78]	[2.16]	[1.70]	[2.45]			
06 Apparel	−41.17	−0.126	−0.176	0.202	61.84	1.586	0.539	0.98	1.44
	[−1.84]	[−2.39]	[−1.22]	[0.46]	[1.78]	[3.69]			
07 Wood	108.77	0.029	0.093	2.464	−128.14	0.995	0.506	0.945	2.37
	[3.70]	[0.61]	[2.30]	[5.00]	[−3.74]	[2.07]			
08 Paper	40.85	0.169	0.180	1.074	−36.00	0.664	0.254	0.681	2.12
	[1.41]	[0.76]	[1.68]	[3.12]	[−1.50]	[0.95]			
09 Printing & Publishing	59.98	0.033	0.087	0.649	−44.48	−0.648	0.421	1.13	1.23
	[3.12]	[0.31]	[1.21]	[2.34]	[−3.01]	[−1.62]			
10 Metals	−3.25	0.087	0.017	0.726	−5.24	2.480	0.673	1.41	1.25
	[−0.18]	[2.90]	[0.24]	[1.33]	[−0.34]	[4.63]			
11 Transportation	96.13	0.170	−0.033	1.954	−77.29	−0.878	0.430	1.48	2.37
	[3.82]	[4.55]	[−0.51]	[3.93]	[−3.86]	[−0.94]			
14 Non-Metallic Minerals	−26.23	0.111	−0.034	1.362	27.67	−0.035	0.591	1.04	1.23
	[−1.14]	[2.25]	[−1.11]	[5.48]	[1.26]	[−0.11]			
15 Petroleum & Coal	141.62	0.118	0.032	0.924	−96.30	−0.986	0.350	1.27	2.58
	[4.11]	[1.89]	[0.55]	[2.02]	[−4.07]	[−1.62]			
16 Chemicals	77.99	0.001	0.054	0.513	−67.46	−0.122	0.635	0.859	1.25
	[5.83]	[0.01]	[1.26]	[2.01]	[−5.85]	[−0.18]			
17 Miscellaneous	94.73	−0.125	−0.111	1.141	−106.25	−1.019	0.678	1.15	1.15
	[4.84]	[−3.23]	[−2.91]	[3.78]	[−4.64]	[−2.53]			

TABLE XIII

General Wage Equations for Production Workers:
Domestic Model; Inter-Industry Model Type 2; Labor Market Demand: Employment Change
1956–68

Industry	C	$\dot{E}^*_{it}$	$\dot{E}_{it}$	$\dot{P}^*_t$	$(W_i/W_T)_{t-1}$	W^*_t	π^*_{it}	$\bar{R}^2$	D.W.	S.E.
01 Food & Beverages	40.19	−0.607	0.037	0.921	−54.07	0.262	2.772	0.642	1.06	1.45
	[1.99]	[−2.09]	[0.48]	[1.76]	[−2.36]	[0.72]	[2.90]			
02 Tobacco	21.93	−0.313	−0.046	2.483	−9.60	−0.272	−2.795	0.748	1.60	3.23
	[1.42]	[−11.59]	[−0.40]	[1.72]	[−0.99]	[−0.32]	[−0.84]			
03 Rubber	142.92	0.193	−0.035	−1.067	−140.82	1.883	−0.016	0.672	1.25	2.07
	[4.61]	[5.83]	[−0.68]	[−1.43]	[−4.62]	[3.20]	[−0.39]			
04 Leather	60.05	0.003	0.151	1.034	−95.34	0.615	1.132	0.401	1.22	1.82
	[1.88]	[0.04]	[1.22]	[1.35]	[−2.09]	[1.34]	[1.50]			
05 Textiles	−11.98	0.095	−0.127	−0.062	9.92	0.869	0.505	0.642	1.20	1.30
	[−0.52]	[2.83]	[−1.62]	[−0.13]	[0.30]	[2.20]	[3.32]			
06 Apparel	−24.22	−0.122	−0.261	−1.44	30.76	0.981	2.047	0.588	1.10	1.36
	[−1.09]	[−2.46]	[−1.85]	[−1.70]	[0.88]	[2.55]	[4.60]			
07 Wood	114.09	−0.003	0.097	0.829	−137.32	1.113	1.307	0.532	1.01	2.31
	[3.98]	[−0.06]	[2.46]	[0.84]	[−4.08]	[1.90]	[2.64]			
08 Paper	8.67	0.325	0.198	−0.851	−8.99	1.460	0.109	0.333	0.98	2.01
	[0.29]	[1.48]	[1.95]	[−1.03]	[−0.36]	[2.54]	[0.16]			
09 Printing & Publishing	48.84	0.026	0.068	0.397	−36.56	0.267	−0.670	0.412	1.15	1.24
	[1.91]	[0.24]	[0.85]	[0.77]	[−1.81]	[0.58]	[−1.65]			
10 Metals	10.22	0.077	−0.014	−0.202	−15.29	0.753	1.746	0.688	1.50	1.22
	[0.54]	[2.58]	[−0.19]	[−0.27]	[−0.96]	[1.80]	[2.63]			
11 Transportation	95.52	0.161	−0.013	1.439	−75.87	0.497	−1.384	0.422	1.49	2.38
	[3.76]	[3.94]	[−0.17]	[1.47]	[−3.74]	[0.61]	[−1.10]			
14 Non-Metallic Minerals	20.16	0.121	−0.026	0.652	22.00	0.620	−0.355	0.614	1.07	1.90
	[0.90]	[2.51]	[−0.85]	[1.49]	[1.02]	[1.94]	[−0.97]			
15 Petroleum & Coal	141.06	0.118	0.031	0.738	−95.98	0.166	−1.051	0.337	1.27	2.61
	[4.04]	[1.88]	[0.53]	[0.78]	[−4.01]	[0.23]	[−1.55]			
16 Chemicals	85.98	−0.012	0.056	0.729	−74.59	−0.244	−0.008	0.629	0.842	1.26
	[3.97]	[−0.10]	[1.28]	[1.39]	[−3.91]	[−0.47]	[−0.01]			
17 Miscellaneous	104.57	−0.098	−0.118	0.013	−119.97	0.847	−1.065	0.738	1.45	1.04
	[5.85]	[−2.73]	[−3.41]	[0.03]	[−5.70]	[3.40]	[−2.94]			

TABLE XIV

General Wage Equations for Production Workers:
Domestic Model; Inter-Industry Model Type 3; Labor Market Demand: Employment Change
1956–68

Industry	C	$\dot{E}^*_{it}$	$\dot{E}_{it}$	$\dot{P}^*_t$	$(W_i/W_T)_{t-1}$	$(W_i/W_T)^*_t$	$\pi^*_{it_t}$	$\bar{R}^2$	D.W.	S.E.
01 Food & Beverages	35.58	−0.744	0.049	1.278	−71.84	23.98	2.786	0.640	1.07	1.45
	[1.47]	[−2.56]	[0.65]	[4.24]	[−1.72]	[0.48]	[2.90]			
02 Tobacco	18.23	−0.276	−0.066	2.004	−68.91	67.62	−3.857	0.791	1.56	2.94
	[1.36]	[−10.12]	[−0.65]	[2.95]	[−3.23]	[3.08]	[−1.27]			
03 Rubber	113.03	0.174	−0.078	0.725	−108.37	1.18	0.039	0.604	1.01	2.28
	[3.50]	[4.79]	[−1.34]	[1.43]	[−3.45]	[0.91]	[0.96]			
04 Leather	−10.08	−0.023	0.154	1.449	−246.38	257.27	1.045	0.547	1.35	1.59
	[−0.34]	[−0.40]	[1.48]	[3.63]	[−4.40]	[4.11]	[1.59]			
05 Textiles	−103.06	0.084	−0.059	0.569	−74.53	212.66	0.559	0.418	1.48	2.39
	[−3.52]	[2.71]	[−0.73]	[1.79]	[−1.49]	[2.96]	[1.30]			
06 Apparel	−41.34	−0.126	−0.171	0.212	66.40	−4.18	1.558	0.529	0.98	1.45
	[−1.82]	[−2.36]	[−1.06]	[0.46]	[1.03]	[−0.08]	[2.85]			
07 Wood	39.51	0.073	0.072	2.254	157.38	108.77	0.860	0.517	1.00	2.34
	[0.70]	[1.30]	[1.70]	[4.44]	[−3.99]	[1.44]	[1.78]			
08 Paper	95.12	0.074	0.248	1.062	21.49	−103.25	0.462	0.315	0.952	2.04
	[2.59]	[0.34]	[2.32]	[3.22]	[0.63]	[−2.26]	[0.69]			
09 Printing & Publishing	62.58	0.044	0.089	0.718	−33.77	−12.85	−0.680	0.411	1.20	1.24
	[3.09]	[0.40]	[1.23]	[2.25]	[−1.20]	[−0.45]	[−1.66]			
10 Metals	−28.37	0.095	0.013	0.866	−43.47	58.20	2.924	0.676	1.32	1.25
	[−1.04]	[3.11]	[0.18]	[1.56]	[−1.24]	[1.21]	[4.51]			
11 Transportation	97.23	0.170	−0.031	1.954	−76.76	−1.463	−0.876	0.418	1.48	2.39
	[2.78]	[4.48]	[−0.42]	[3.89]	[−3.30]	[−0.05]	[−0.92]			
14 Non-Metallic Minerals	−49.41	0.088	−0.029	1.202	9.22	40.37	0.202	0.584	0.994	1.24
	[−0.92]	[1.26]	[−0.89]	[2.89]	[0.21]	[0.48]	[0.34]			
15 Petroleum & Coal	118.01	0.104	0.018	0.914	−110.99	30.64	−0.680	0.344	1.40	2.59
	[2.53]	[1.59]	[0.29]	[1.99]	[−3.61]	[0.76]	[−0.93]			
16 Chemicals	77.59	−0.002	0.065	0.512	−53.26	−14.47	0.002	0.629	0.861	1.26
	[5.74]	[−0.02]	[1.32]	[1.99]	[−1.63]	[−0.46]	[0.03]			
17 Miscellaneous	16.54	−0.037	−0.112	1.252	−145.11	128.20	−0.112	0.723	1.55	1.07
	[0.51]	[−0.78]	[−3.17]	[4.43]	[−5.79]	[2.91]	[−0.23]			

Table XV

Goodness of Fit of Various Models

Industry	Preferred General Models with Contract-Weighted Independent Variables						Standard Models	
	Labor Market Demand: U^{-1}			Labor Market Demand: E_i			Domestic[a]	International[b]
	Mkt.[c] Type	Inter-Ind. Type	$\bar{R}^2$ D.W.	Mkt. Type	Inter-Ind. Type	$\bar{R}^2$ D.W.	$\bar{R}^2$ D.W.	$\bar{R}^2$ D.W.
Food & Beverages	I	2	0.680 1.08	I	3	0.652 1.08	0.280 0.79	0.348 0.84
Tobacco	D	3	0.363 1.62	D	3	0.791 1.56	−0.034 1.68	0.000 1.69
Rubber	D	3	0.608 0.80	D	2	0.672 1.25	0.560 0.77	0.552 0.78
Leather	D	1	0.739 2.13	D	3	0.547 1.35	0.659 1.64	0.685 1.57
Textiles	I	3	0.752 1.54	I	3	0.716 1.58	0.627 1.39	0.633 1.46
Apparel	D	2	0.643 1.22	D	2	0.588 1.10	0.631 0.92	0.473 1.24
Wood	D	2	0.478 1.34	D	2	0.532 1.01	0.449 0.50	0.525 1.45
Paper	I	3	0.540 1.24	D	2	0.333 0.97	0.401 0.84	0.388 0.83
Printing & Publishing	I	3	0.573 1.46	I		0.530 1.39	0.352 0.92	0.365 1.02
Metals	I	2	0.704 1.80	I	3	0.724 1.73	0.483 1.03	0.478 1.12
Trans.	I	1	0.242 1.59	I	3	0.437 1.56	0.091 1.47	0.078 1.50
Non-Met. Minerals	I	2	0.594 1.06	I	2	0.615 1.12	0.524 1.35	0.546 1.41
Petroleum & Coal	D	3	0.344 1.36	D	1	0.350 1.27	0.268 1.12	0.253 1.11
Chemicals	D	1	0.645 1.02	D	1	0.635 0.86	0.609 1.03	0.603 1.02
Miscell-aneous	D	3	0.665 1.34	D	2	0.738 1.45	0.573 1.02	N.A.

[a] This model is as follows:

$$\dot{W}_{it} = a_0 + a_1 U_t^{-1} + a_2 \dot{P}_t + a_3 \dot{P}_{t-1} + a_4 \pi_{it} + a_5 (W_i/W_T)_{t-1}$$

[b] This model is the above model with U.S. wage changes added as an additional explanatory variable.

[c] "I" denotes "international", "D" denotes "domestic".

TABLE XVI

Preferred Equations for Production Worker Wage Changes

Contract Models
1956–68

Industry	C	Labor Market Demand	Consumer Prices[b]	Inter-Industry Effects	Profits	U.S. Wage Changes	$\bar{R}^2$ D.W.[c]	S.E.
Food[a] & Beverages	23.17	$5.27\,(U_t^{-1}-U_t^{-1*})$	1.000	$-41.14\,(W_1/W_T)_{t-1}$ + $0.285\,\dot{W}_t^*$	$3.225\,\pi_{it}^*$	$0.501\,(\dot{W}_{USit})^*$	0.359	1.45
	[1.15]	[0.78]	(c)	[−1.86] [1.25]	[2.63]	[1.84]	1.06	
Tobacco	2.25	$-0.272\,\dot{E}_{it}$	$1.000\,\dot{P}_t^*$	$-65.91\,(W_1/W_T)_{t-1}$ + $68.65\,(W_1/W_T)_t^*$			0.779	7.96
	[0.29]	[−10.01]	(c)	[−3.10] [3.16]			1.49	
Rubber	129.23	$0.187\,(\dot{E}_{it}-\dot{E}_{it}^*)$ + $0.166\dot{E}_{it}^*$		$-126.72\,(W_1/W_T)_{t-1}$ + $1.206\,\dot{W}_t^*$			0.671	2.07
	[4.86]	[5.86] [2.98]		[−4.90] [3.895]			1.19	
Leather	146.71	$30.42\,(U_t^{-1}-U_t^{-1*})$ + $38.07\,U_t^{-1*}$	$1.000\,\dot{P}_t^*$	$-223.03\,(W_1/W_T)_{t-1}$			0.640	1.20
	[7.00]	[6.84] [7.64]	(c)	[−7.02]			2.00	
Textiles[a]	−46.67	$0.067\,(\dot{E}_{it}-\dot{E}_{it}^*)$	$0.263\,\dot{P}^*$	$-104.85\,(W_1/W_T)_{t-1}$ + $164.62\,(W_1/W_T)_t^*$	$0.107\,\pi_{it}^*$	$0.495\,(\dot{W}_{USit})^*$	0.712	1.17
	[−1.41]	[2.26]	[0.87]	[−2.32] [2.64]	[2.99]	[2.65]	1.43	
Apparel	29.88	$28.65\,(U_t^{-1}-U_t^{-1*})$	$1.019\,\dot{P}^*$	$-48.78\,(W_1/W_T)_{t-1}$ + $0.759\,\dot{W}_t^*$	$0.655\,\pi_{it}^*$		0.618	1.31
	[1.27]	[3.32]	[1.65]	[−1.33] [2.11]	[0.68]		1.03	
Wood	113.80	$0.096\,\dot{E}_{it}$	$0.860\,\dot{P}_t^*$	$-136.97\,(W_1/W_T)_{t-1}$ + $1.101\,\dot{W}_t^*$	$1.296\,\pi_{it}^*$		0.542	2.28
	[4.06]	[2.50]	[1.03]	[−4.17] [2.02]			1.01	
Paper	104.55	$37.99\,(U_t^{-1}-U_t^{-1*})$ + $3.41\,U_t^{-1*}$	$1.000\,\dot{P}_t^*$	$-89.12\,(W_1/W_T)_t^*$		$0.409\,(\dot{W}_{USit})^*$	0.421	1.73
	[3.14]	[5.02] [0.51]	(c)	[−3.16]		[1.20]	1.12	
Printing & Publishing	23.90	$6.08\,(U_t^{-1}-U_t^{-1*})$		$-76.05\,(W_1/W_T)_{t-1}$ + $50.01\,(W_1/W_T)_t^*$		$0.942\,(\dot{W}_{USit})^*$	0.553	1.08
	[1.38]	[1.72]		[−3.89] [2.40]		[3.39]	1.34	
Metals[a]	6.19	$0.070\,(\dot{E}_{it}-\dot{E}_{it}^*)$ + $0.205\,\dot{E}_{it}^*$	$0.835\,\dot{P}_t^*$	$-69.42\,(W_1/W_T)_{t-1}$ + $54.11\,(W_1/W_T)_t^*$	$0.217\,\pi_{it}^*$	$0.747\,(\dot{W}_{USit})^*$	0.724	1.15
	[0.22]	[2.39] [2.60]	[1.63]	[−2.07] [1.22]	[3.35]	[2.97]	1.73	
Transportation	78.49	$0.152\,(\dot{E}_{it}-\dot{E}_{it}^*)$ + $0.222\,\dot{E}_{it}^*$	$1.000\,\dot{P}_t^*$	$-65.65\,(W_1/W_T)_{t-1}$		$0.414\,(\dot{W}_{USit})^*$	0.365	2.35
	[3.43]	[4.63] [3.46]	(c)	[−3.42]		[1.90]	1.52	
Non-Metallic Minerals	−28.50	$0.105\,\dot{E}_{it}^*$	$0.751\,\dot{P}_{it}^*$	$28.53\,(W_1/W_T)_{t-1}$ + $0.526\,\dot{W}_t^*$			0.618	1.18
	[−1.56]	[2.32]	[1.76]	[1.59] [1.90]			1.02	
Petroleum & Coal	102.88	$0.019\,(\dot{E}_{it}-\dot{E}_{it}^*)$ + $0.124\,\dot{E}_{it}^*$	$0.577\,\dot{P}_t^*$	−70.92			0.328	2.62
	[4.09]	[0.33] [1.99]	[1.40]	[−3.94]			1.23	
Chemicals	77.99	$0.052\,\dot{E}_{it}$	$0.487\,\dot{P}_t^*$	$-67.91\,(W_1/W_T)_{t-1}$			0.650	1.23
	[6.63]	[1.58]	[2.22]	[−6.47]			0.86	
Miscellaneous	−7.22	$1.94\,(U_t^{-1}-U_t^{-1*})$ + $8.62\,\dot{U}_t^{-1*}$	$0.946\,\dot{P}_t^*$	$-115.02\,(W_1/W_T)_{t-1}$ + $122.11\,(W_1/W_T)_t^*$	$0.417\,\pi_{it}^*$	N.A.	0.665	1.17
	[−0.20]	[0.28] [1.23]	[1.64]	[−3.25] [2.60]	[1.05]		1.33	
Food & Beverages	23.94		$1.000\,\dot{P}_t^*$	$-42.68\,(W_1/W_T)_{t-1}$ + $0.216\,\dot{W}_t^*$	$3.497\,\pi_{it}^*$	$0.454\,(\dot{W}_{USit})^*$	0.364	1.44
	[1.20]		(c)	[−1.94] [1.03]	[2.99]	[1.72]	1.03	
Textiles	−0.018	$22.82\,(U_t^{-1}-U_t^{-1*})$	$1.080\,\dot{P}_t^*$		$0.295\,\pi_{it}^*$	$0.452\,(\dot{W}_{USit})^*$	0.720	1.15
	[−0.01]	[3.27]	[2.93]		[0.87]	[3.25]	1.56	
Metals	37.37	$12.05\,(U_t^{-1}-U_t^{-1*})$		$-77.68\,(W_1/W_T)_{t-1}$ + $36.04\,(W_1/W_T)_t^*$	$2.377\,\pi_{it}^*$	0.820	0.700	1.20
	[1.89]	[2.21]		[−2.25] [0.81]	[4.28]	[3.56]	1.73	

[a] An alternate model for this industry is presented below.

[b] A "c" below the coefficient indicates its value was constrained.

[c] For models with the coefficient on price changes constrained to unity $\bar{R}^2$ is for an equation predicting real wage changes and is not directly comparable with the $\bar{R}^2$ for other equations. The standard error of estimate is, of course, comparable across the various models.

N.A. means that data are not available for the independent variable.

TABLE XVII

All Manufacturing; Production Worker Wage Equations
With Alternative Tax Variables

Eq. No.	Constant	$\dot{E}_t$	$\dot{E}^*_t$	π^*_t	$(\dot{W}us_t)^*$	$\left[\frac{\dot{P}(1-a)}{1-m}\right]^*_t$	$\left[\frac{m_x-m_{-1}}{1-m_{-1}}\right]^*_t$	$\left[\frac{a_x-a_{-1}}{1-a_{-1}}\right]^*_t$	$\left[\frac{a}{1-a}\right]^*_t$	$\left[\frac{m}{1-m}\right]^*_t$	$\bar{R}^2$/D.W.	S.E.
1	−4.36	0.088	0.276	0.867	0.513	1.211		−193.83			0.674	1.08
	[−2.02]	[2.49]	[2.85]	[1.23]	[2.03]	[5.19]		[−2.14]			1.42	
2	−6.37	0.0833	0.236	1.611	0.267	0.864	105.76				0.669	1.09
	[−2.70]	[2.86]	[2.39]	[2.12]	[1.02]	[4.20]	[1.90]				1.50	
3	−11.90	0.036	0.150	1.631	0.569	−0.071			64.24		0.714	1.01
	[−4.01]	[1.02]	[1.55]	[2.41]	[2.39]	[−0.19]			[3.38]		1.68	
4	−18.08	0.031	0.146	2.483	0.071	0.210				46.74	0.737	0.97
	[−4.68]	[0.92]	[1.58]	[3.44]	[0.29]	[0.82]				[4.04]	1.66	
5	−13.90	0.037	0.131	1.527	0.785	0.016		−307.42	84.81		0.784	0.88
	[−5.31]	[1.23]	[1.56]	[2.60]	[3.68]	[0.05]		[−3.97	[4.90]		1.94	
6	−18.96	0.037	0.127	2.882	−0.031	0.172	87.11			44.66	0.750	1.95
	[−5.00]	[1.13]	[1.41]	[3.92]	[−0.13]	[0.69]	[1.84]			[3.94]	1.79	
7	−6.01	0.092	0.249	1.392	0.376	1.113	96.33	−179.46			0.690	1.05
	[−2.62]	[2.67]	[2.60]	[1.87]	[1.46]	[4.76]	[1.82]	[−2.02]			1.52	
8	−12.46	0.043	0.141	1.962	0.457	−0.036	72.33		58.36		0.720	1.00
	[−4.21]	[1.23]	[1.47]	[2.76]	[1.84]	[−0.10]	[1.41]		[3.03]		1.74	
		$(U_t^{-1}-U_t^{-1*})$										
9	−1.94	31.29		0.407	0.497	1.467		−118.89			0.745	0.96
	[−1.02]	[6.34]		[0.69]	[2.54]	[6.74]		[−1.50]			1.39	
10	−3.38	30.19		0.883	0.360	1.237	80.95				0.749	0.95
	[−1.65]	[6.10]		[1.39]	[1.70]	[6.24]	[1.72]				1.45	

11	−8.70	23.22	0.951	0.675	0.395			54.10		0.791	0.87
	[−3.43]	[4.63]	[1.73]	[3.64]	[1.26]			[3.58]		1.78	
12	−13.79	21.65	1.719	0.235	0.623				38.21	0.799	0.85
	[−3.98]	[4.29]	[2.80]	[1.29]	[2.51]				[3.89]	1.74	
13	−11.04	19.91	1.002	0.828	0.361		−254.46	74.63		0.836	0.77
	[−4.73]	[4.40]	[2.06]	[4.89]	[1.31]		[−3.71]	[5.16]		2.09	
14	−14.71	20.81	2.057	0.149	0.568	72.11			37.29	0.808	0.83
	[−4.29]	[4.20]	[3.26]	[0.80]	[2.31]	[1.74]			[3.87]	1.86	
15	−3.21	30.18	0.799	0.398	1.378	75.71	−108.78			0.754	0.94
	[−1.58]	[6.16]	[1.27]	[1.97]	[6.24]	[1.62]	[−1.39]			1.45	
16	−9.23	22.89	1.209	0.591	0.395	56.35		50.74		0.794	0.86
	[−3.62]	[4.59]	[2.08]	[3.02]	[1.27]	[1.30]		[3.34]		1.83	

TABLE XVIII

All Manufacturing Production Worker Wages: Selected Equations with Tax Scaled Variables[a]

Eq. No.	Constant	$(V\dot{E}_t)^*$	$(U_t^{-1} - U_t^{-1*})$	$(V\pi_t)^*$	$(V\,\dot{W}us_t)^*$	$(V\dot{P})^*$	$\left[\frac{m_x - m_{-1}}{1-m_{-1}}\right]_t^*$	$\left[\frac{a_x - a_{-1}}{1-a_{-1}}\right]_t^*$	$\left[\frac{a}{1-a}\right]_t^*$	$\bar{R}^2$/D.W.	S.E.
1	−6.95		22.42	0.542	0.760	0.356			48.78	0.814	0.82
	[−2.84]		[4.95]	[1.08]	[4.24]	[1.23]			[3.56]	1.82	
2	−7.30	0.261		0.445	0.864	0.168			47.72	0.768	0.91
	[−2.40]	[3.25]		[0.69]	[3.88]	[0.50]			[2.75]	1.64	
3	−2.45		30.44	0.460	0.564	1.274	91.12	−78.48		0.787	0.87
	[−1.23]		[7.95]	[0.84]	[2.95]	[6.53]	[2.15]	[−1.22]		1.65	
4	−2.64	0.411		0.076	0.846	1.060	105.04	−127.15		0.774	0.90
	[−1.29]	[7.04]		[0.13]	[3.82]	[5.54]	[2.40]	[−1.93]		1.57	
5	−2.23	0.177	19.25	0.185	0.729	1.192	96.70	−95.70		0.793	0.86
	[−1.13]	[1.50]	[2.28]	[0.33]	[3.34]	[6.21]	[2.30]	[−1.48]		1.68	

[a] A V in front of a variable in this table indicates that it has been scaled by the factor $\left[\frac{1-a}{1-m}\right]$.

chapter four

LABOR PRODUCTIVITY IN CANADIAN MANUFACTURING

INTRODUCTION

In this chapter we present the empirical results we have obtained for the productivity equations estimated for the Canadian manufacturing sector. These equations have been estimated for the sector as a whole as well as for each of the major group industries within the sector. As was discussed in chapter two, the main reason for this aspect of our empirical work is to derive estimates of normal labor productivity which are required as inputs into the calculation of normal unit labor costs for the price equations. In order to calculate normal unit labor costs, we must make adjustments for the short-run cyclical and erratic movements in productivity, in order to determine the underlying long-run productivity trends.

On the basis of the theoretical analysis presented in chapter two, we specify the following two alternative equations determining labor productivity:

$$\ln\left[\frac{M_t}{C_t}\right] = \alpha_0 + \alpha_1 t + \beta \ln\left[\frac{Q^p_t}{Q_t}\right] + \gamma \ln\left[\frac{Q_t}{Q^p_t}\right] \qquad (1)$$

and,

$$\frac{M_t}{C_t} = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + (\beta_0 + \beta_1 t)\left[\frac{Q^p_t - C_t}{C_t}\right] + (\gamma_0 + \gamma_1 t)\left[\frac{Q_t - Q^p_t}{C_t}\right] \qquad (2)$$

where M_t = manhours at time t

C_t = capacity (expressed in output units) at time t

Q^p_t = planned output at time t

Q_t = actual output at time t

These equations correspond to logarithmic and linear short-run adjustments of manhours to changes in output, respectively, as described e.g. by equations (30) and (31) of chapter two.

These equations have been applied to the estimation of the unit requirements of several kinds of labor input. Total employment may be divided into employment of production workers and non-production workers, respectively; secondly, total average weekly hours worked by production workers may be divided into standard (or straight-time) hours and overtime hours. We have thus been able to estimate manhour functions for the following six groups of labor:

(i) production worker total hours,
(ii) production worker standard hours,
(iii) overtime hours,
(iv) non-production worker hours,
(v) total manhours by all workers,
(vi) total worker standard hours.

The precise definitions of these various kinds of manhours are given in section two below. We may make allowances for the overtime hours of production workers since average weekly hours data for non-production workers are not available. However, since non-production workers are typically paid only on a salary basis, this omission is not important. The above six categories thus give us all the possible combinations involving the two groups of labor, as well as their totals divided into straight-time hours and overtime components. Note that an equation predicting (vi), total worker standard hours, can be viewed as an employment function.

We should point out that in the price equations themselves, the normal unit labor cost estimates used are based on the productivity equations estimated for total manhours—i.e. equation (v) above. The manhour functions estimated for the other classes of labor are included here because of their intrinsic interest. As noted in chapter two, the productivity function is important in its own right, since it enables one to determine the magnitudes of wage increases that can be granted without imposing inflationary pressures on the economy and accordingly is of crucial importance in any implementation of a policy of wage and price guidelines. If wages are rising at the trend rate of increase in national productivity, the appropriate price guidelines are that (*cet. par.*) industries whose trend rate of productivity increase is above the national average should *reduce* prices, and those whose trend rate of productivity increase is below the national average should raise prices.

Both the logarithmic and linear version of the productivity functions were fitted to the above six labor inputs for each major industry and for all manufacturing. While in general the results were similar, in this chapter we present mainly the logarithmic equations, since the relevant trends and elasticities are more readily apparent. In certain instances, logarithmic equations were not

feasible,[1] and linear equations are presented instead; these cases are clearly identified in the relevant tables.

Finally, we should recall that our theoretical analysis suggested that some constraints should be satisfied by the coefficients β, γ of (1) (or correspondingly of (2)). Specifically, in the case of production workers straight-time hours, it was argued that we would expect $\beta > \gamma$, since firms will have greater flexibility in hiring workers over a longer adjustment period. Secondly, in the case of overtime workers, one would expect this inequality to be reversed. The reason for this is that in the short run much of the adjustment of labor input to fluctuations in output takes place by changing the amount of overtime hours worked. Since overtime hours tend to be more expensive, in the longer run, the firm will adjust to any more permanent increases in output by increasing the amount of labor it hires at standard rates or by altering its capital usage. Thirdly, since non-production workers are typically hired with a longer time horizon, we would expect their employment (and hence manhours worked) to be relatively insensitive to short-run fluctuations in output—that is, one would expect $\gamma \leqq 0$. Since some regressions at the all manufacturing level confirmed this result, this assumption was accordingly adopted for the industry equations. Furthermore, since production workers outnumber non-production workers, and since standard hours substantially exceed overtime hours, one would expect the inequality $\beta > \gamma$ to hold for total workers as well. These expected inequalities are of course empirically testable hypotheses and provide a set of tests for the validity of the theoretical model.

VARIABLES

A full description of the data and their method of construction and sources is given in the Appendix.[2] Here we simply describe the variables in sufficient detail to permit an understanding of the empirical results that follow.

Manhours

Direct data for total employment (L), employment of production workers (L_1), and employment of non-production workers (L_2), were obtained, while data on average weekly hours (AWH) of production workers were also available. The standard work week for production workers was assumed to be 37.5 hours, while that of non-production workers was assumed to be 40 hours. Because of

[1]In the case of overtime hours, in three industries the linear equation is superior. This arises from the fact that we have defined overtime hours to be average weekly hours paid in excess of 37.5, so that industries where the work-week (for production workers) is actually less than that amount, will show a negative amount of overtime for which, of course, no logarithm exists. The second exception occurs with non-production workers and arises for much the same reason. Non-production worker employment is obtained residually by subtracting production worker employment from total employment. In a couple of industries, where there are relatively few non-production workers, because of statistical reasons (arising mainly from our method of seasonal adjustment), this procedure led to a negative estimate of non-production workers. Thus for those industries where either of these difficulties occur, we present the linear equations for the corresponding type of labor input.

[2] See Appendix, section 2, and section 6.

data limitations the former were assumed to work overtime, the amount of which was obtained by subtracting 37.5 from AWH. With these data the following components of manhours were calculated:

Production worker total hours (M_1):

$$M_1 = L_1 \cdot AWH \cdot 52$$

Production worker standard hours (M_2):

$$M_2 = L_1 \cdot 37\tfrac{1}{2} \cdot 52$$

Overtime hours of production worker (M_3):

$$M_3 = L_1 \cdot (AWH - 37\tfrac{1}{2})$$

Non-production worker hours (M_4):

$$M_4 = L_2 \cdot 40 \cdot 52$$

Total worker hours (M_5):

$$M_5 = L \cdot AWH \cdot 52$$

Total worker standard hours (M_6):

$$M_6 = L \cdot 40 \cdot 52$$

Actual Output

Actual output Q_t is measured by the Index of Industrial Production for the relevant industry.

Capacity

An index of capacity (measured in the same units as the output index) has been constructed based on the method used in the Wharton School Indexes constructed for the United States (see Klein and Summers (1966). The procedure used is described in more detail in the Appendix, section 6.

Planned Output

Planned output is defined to be a moving average of output in the three most recent periods, with weights being in the proportion 3:2:1. That is:

$$Q^p_t = \frac{1}{6}(3Q_{t-1} + 2Q_{t-2} + Q_{t-3}).$$

This weighting scheme is of course arbitrary. However, alternative weighting procedures—including estimating the weights from the data—were in fact tried at the all manufacturing level, but the above procedure yielded superior results. In view of this finding and also the fact that it had been used with some success in the Wilson-Eckstein study (1964), we adopted it here as well.

EMPIRICAL RESULTS

Equations (1) and (2) were estimated for the six components of manhours defined in section two. As we have already indicated, typically only the logarithmic equations are reported, the exceptions being some of the industry equations

for overtime hours or non-production manhours, where for the reasons mentioned, the linear formulation proved to be markedly superior. The regression results are given in Table XIX, where the linear equations are indicated by an asterisk.

The equations were originally estimated using Ordinary Least Squares. However, because of severe autocorrelation in the residuals,[3] the equations were re-estimated using a Hildreth-Lu transformation (1960). $\bar{R}^2$ denotes the coefficient of determination corrected for degrees of freedom in terms of the transformed variables, while the numbers in parentheses below $\bar{R}^2$ are the R^2 in terms of the original variables. D.W. and ρ denote the Durbin-Watson statistic and the estimate of the auto-regression parameter respectively. The precise period of estimation varies from industry to industry, as indicated in the Table.

All Manufacturing

We first consider the results for the manufacturing sector as a whole. As can be seen by the high values for $\bar{R}^2$ and the large t-values for the regression coefficients, the equations fit very well indeed, and all variables are highly significant. In all cases the relative magnitude of the coefficients conform to our *a priori* expectations. As we have already discussed, since non-production manhours represent an input which is an overhead input in the short run, their employment is likely to be relatively insensitive to current output Q_t. This was corroborated by an initial regression which yielded an estimate for γ which was insignificantly different from zero. Accordingly, the short-run adjustment coefficient was suppressed. In the case of production worker total hours (M_1), production worker standard hours (M_2), and the two corresponding quantities for total workers (M_5, M_6), the hypothesized inequality is satisfied, while in the overtime hours equation the reverse inequality holds, again in accordance with our expectations. There can be little question but that these manufacturing sector results are satisfactory and provide strong support for the productivity model used.

The elasticities implied by these equations are presented in the first two columns of Table XX (i). The equation for M_2 implies a short-run elasticity of production worker standard time manhours (or equivalently production worker employment) with respect to output of 0.56. However, an increase in Q_t will, by the definition of Q^p_t, affect plans for the next three quarters and these in turn will affect employment. The elasticity of employment with respect to output when this adjustment in plans is taken into account equals the coefficient β. Thus the intermediate-run elasticity of production worker straight-time hours is indicated to be 1.01. Taken together, these results imply that at the all manufacturing level, a one per cent increase in output will increase production worker standard time hours by 0.56 per cent within one quarter and by one per cent

[3] In this situation we are not surprised by the severe autocorrelation of the structural equations. We assume that technical change may be approximated by a smooth trend. Since this is unlikely to be the case, one would expect the oscillations of technical change about its trend to show up in serially correlated residuals.

within a year. Furthermore, since the basic relationship between capacity output and employment implies a unitary long-run elasticity (see equation (26) of chapter two), we see further that the total adjustment is in fact completed within one year.

The result that production worker employment is relatively sensitive to current output, combined with the fact that the lags for complete adjustment are relatively short, has important policy implications. For it means that if the government adopts an expansionary policy to stimulate the economy, it does not take too long for the increase in output generated to give rise to an increase in employment of this group of workers. Over half the adjustment will take effect within the first quarter and the remaining 44 per cent will be completed within one year.

As one would expect, the elasticity of non-production workers is much lower that that of production workers. Indeed the short-run elasticity is zero by assumption, while the intermediate elasticity is only 0.31. Since the long-run elasticity of non-production worker manhours is (by assumption) also 1, these results imply that only 31 per cent of the total response to a change in output will be completed within a year. Thus, expansionary policies which increase output will be much less effective in stimulating an increase in non-production worker employment. On the other hand, the extremely high short-run elasticity of overtime hours with respect to output (3.58) suggests that firms respond very strongly indeed to unexpected fluctuations in output by altering the work week, but that this response declines as the period of adjustment increases.

Aggregating over these labor inputs yields elasticities which approximate a weighted average of those obtained for the component groups.[4] Thus, for example, the short-run elasticity of production worker total hours is 0.79, which lies between the corresponding figure for straight-time hours (0.56) and for overtime hours (3.58). Similarly, the total worker standard hours elasticity—which is really an aggregate all manufacturing employment elasticity—is 0.43, and lies between 0.56 and 0.

As indicated above, the coefficient of time in equation (1) represents the rate of productivity increase of the corresponding type of labor. These are summarized in column 3 of Table XX, where these coefficients are multiplied by four to express them at annual rates. The results imply an annual average increase in labor productivity (output per total manhour) in manufacturing of about 3.3 per cent, with a 3.1 per cent increase in output per standard hour (or output per employee). These equations also imply that unit manhour requirements of production workers have declined at a more rapid rate than those of non-production manhours. For production workers these requirements have declined at 3.65 per cent per annum (3.4 per cent for standard hours, 5.8 per cent for overtime) while unit requirements of non-production workers

[4] In principle the weights should approximate the proportions of each component of hours in the total.

have diminished at an annual rate of 2.4 per cent. This reflects, of course, the increase in the proportion of non-production workers in total employment which has occurred.

Individual Industries

Our discussion of the results for the major group of two digit industries follow the same format as those for all manufacturing. In the main, the results are satisfactory, with high $\overline{R}^2$, particularly when the equations are transformed back to their original units, and with most variables being highly significant. Generally speaking, the relative magnitudes of the coefficients β and γ are as we have hypothesized. The inequality $\beta > \gamma$ holds for M_1, M_2, M_5, and M_6 for 13 out of the 15 industry equations and in the other two industries the inequality only just fails to hold. The reverse inequality, which we have argued should apply to overtime workers, holds in nine industries and $\beta \leqq \gamma$ in three others. The three industries where it is clearly violated are wood, non-metallic minerals and chemicals. In the case of non-production workers, the inequality $\beta > \gamma$ holds for nine industries; in the remaining six industries $\beta = 0$, implying that in these cases non-production worker employment depends only upon capacity output and does not even depend upon the extent to which planned output deviates from capacity. This is not an unreasonable finding and, in general, it is fair to say that the sign patterns are remarkably consistent with the theory. Accordingly, these results, taken as a whole, must be judged to be satisfactory.

The elasticities are reported in the first two columns of Tables XX (ii) to XX (xvi). In the case where they are based upon the logarithmic function they are, of course, constant; where the linear model has been used the elasticities vary with time[5] in which cases the figures reported are those at the mean of our sample period, the fourth quarter of 1960. The same components apply to the productivity trends reported in the final column of the same table.

Overall, the estimates are generally consistent with those we have obtained at the manufacturing level. While the various elasticities do show a good deal of inter-industry variation, they tend to fluctuate about the corresponding estimate obtained using the aggregate equation. Furthermore, with the exception of the miscellaneous manufacturing industry, the intermediate-run elasticity of non-production workers is always less than that for production workers. Similarly, the elasticity of overtime hours is always higher than that for standard hours, both of these results being consistent with the behavior of the aggregate equation, and with the theoretical model.

Turning to some of the specific industries, the most elastic response to output is found in apparel, where the short-run overtime elasticity is as high as 15 and with the elasticities for the other categories of manhours being high as well. Tobacco and leather also show very high short-run overtime elasticities, but the standard hours elasticities are much lower. In contrast, the metals industry has high elasticities for standard hours, but somewhat lower for overtime hours. At

[5] See equations (32), (33) of chapter two.

the other end of the scale is the petroleum and coal industry, where, as already indicated, all short-run elasticities (with the exception of production worker standard hours) are zero, while the intermediate-run elasticities are also lower than for any other industry. The elasticity for total worker standard hours, for example, implies that a one per cent increase in output will result in only a 0.18 per cent increase in employment after a year. Since we postulate that the long-run elasticity is unity, this implies an extremely long adjustment lag in employment, and suggests that this industry may respond to increases in output by using other inputs more intensively. Given the technological characteristics of this industry, (high capital intensity and relatively great importance of natural resource inputs), this result is perhaps not surprising. Also at the less elastic end of the range are the food and beverage, tobacco, rubber, and printing and publishing industries.

We turn now to the estimates of productivity trends. In order to provide a general picture of the results provided by these figures, we have divided the industries into high, medium and low productivity groups with respect to the different categories of manhours, as summarized in Table XXI. These groups have been defined as follows. The high productivity group for a particular kind of manhours consists of those industries whose productivity trends exceeds the productivity trend of the corresponding category for the all manufacturing by more than 0.5 per cent at annual rates; the low productivity group consists of those industries where the trend increase falls short of the trend for all manufacturing by more than 0.5 per cent; the medium productivity group are thus those industries where the trend is within plus or minus 0.5 per cent of the aggregate trend. With these definitions, we obtain the following general results.

(i) Three industries—tobacco, textiles, and chemicals—show uniformly high productivity trends in all categories of labor.

(ii) One other industry, petroleum and coal, has high productivity increases as far as production worker standard hours are concerned, but only medium productivity increases in overtime and non-production worker manhours.

(iii) One industry, printing and publishing, indicates uniformly low productivity increases in all categories of labor.

(iv) Four industries—apparel, wood, non-metallic minerals, and leather—are uniformly low with respect to production workers but high with respect to non-production workers. A fifth industry, paper, is low with respect to production worker standard hours as well as non-production workers, but high for overtime workers.

(v) The remaining five industries—rubber, metals, transportation, food and beverages, and miscellaneous manufacturing—could be classified as showing average increases on productivity, although in all cases there are deviations for some categories of labor. Thus, for example, overtime labor in the important metals industry has shown less than average productivity gains. The same applies to transportation, where non-production workers as well appear to be below average.

As a summary indication of the overall productivity trends in the different industries, it is useful to consider the productivity of total manhours M_5. From Table XXI we see that on the average tobacco, textiles, chemicals, and petroleum and coal are industries of high productivity growth; rubber, metals, transportation equipment, and miscellaneous show medium productivity increases; the remaining seven industries have a lower growth of labor productivity.

While the productivity trends summarized in Table XX provide interesting statistics, as we have stressed before, they could also be important for a guidelines policy. For, if one accepts them as providing reliable estimates of productivity trends, they may be used with other evidence to derive relative price guidelines applicable to broad industry groups. The aggregate trend in productivity for the manufacturing sector as a whole may also be useful in the determination of appropriate wage guidelines.

CONCLUSIONS

Overall we regard our productivity results as highly satisfactory. Not only are the statistical properties of the equations excellent, but also the implied parameter estimates are plausible and consistent with the rationale underlying the model. Our results also appear to be generally consistent with the few previous studies carried out for Canada. Specifically, Bodkin, Bond, Reuber and Robinson (1966) obtained estimates of the overall trend in labor productivity at the all manufacturing level of about four per cent per annum, as compared to our figure of 3.31 per cent. They did not calculate these figures for the other components of manhours and to our knowledge, the present study is the only one examining this question.

More recently, Reuber (1970) has estimated a set of two-digit total manhour equations (in our notation M_5), as part of his study of industry wage equations. The model he uses regresses total manhours in the various industries on the output of that industry, a linear time trend and lagged manhours, implying of course a simple geometric distributed lag. In terms of goodness of fit and the usual statistical criteria, there is little doubt that our industry equations are superior. In particular our $\bar{R}^2$, are consistently higher and the t-ratios on the time trend—the coefficient of which is essentially the estimate of the productivity trends —are frequently several times as large as those obtained by Reuber.

Reuber restricts his comments on his results to a discussion of their implied adjustment lags. The underlying dynamic specification of his model is different from the one developed here so that a comparison of such lags is rather difficult. Furthermore, his industry breakdown is not identical to ours. Nevertheless, both studies agree that there is considerable difference at the rates at which the various industries adjust their manhours in response to an increase in output. In many of the specific industries the two models are roughly consistent in their implications; for example, in both cases the apparel industry is found to adjust almost entirely within a quarter, while the printing and publishing industry is sluggish in its response. On the other hand inconsistencies also arise. While

Reuber finds complete within period adjustment to occur in both the transportation and chemical industries, the present analysis suggests that these are in fact two of the slower industries in their adjustment patterns.

In conclusion, we repeat that our main purpose in undertaking this study of productivity, is to obtain reliable estimates of productivity trends in order to construct estimates of normal unit labor costs. On the basis of the results reported in this chapter, we have selected the equations to be used with wage rates to derive indexes of normal unit labor costs. Equations with these latter variables as one of the determinants of prices are discussed in the next chapter.

Table XIX

Productivity Equations[a]

(i) All Manufacturing

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	3.308	−0.00913	1.085	0.785	0.995	2.05	0.950	49:4—69:4
	[149.0]	[−22.84]	[17.81]	[15.79]	(0.999)			
M_2	3.190	−0.00845	1.006	0.555	0.995	2.08	0.950	
	[161.3]	[−23.72]	[15.55]	[12.54]	(0.999)			
M_3	1.042	−0.0144	2.210	3.578	0.868	1.81	0.701	
	[25.72]	[−18.40]	[8.46]	[9.86]	(0.978)			
M_4	2.305	−0.00591	0.312	—	0.987	2.49	0.739	
	[203.6]	[−27.00]	[4.45]		(0.991)			
M_5	3.628	−0.00528	0.941	0.668	0.999	2.22	0.818	
	[478.5]	[−56.60]	[22.15]	[14.91]	(0.999)			
M_6	3.582	−0.00774	0.859	0.433	0.999	2.33	0.782	
	[609.1]	[−68.12]	[24.53]	[10.76]	(0.999)			

(ii) Food and Beverages

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	1.0158	−0.00535	0.652	0.355	0.908	2.63	0.892	51:2—69:4
	[36.62]	[−10.40]	[2.10]	[3.087]	(0.984)			
M_2	0.870	−0.00456	0.695	0.276	0.919	2.59	0.879	
	[41.17]	[−11.23]	[2.660]	[2.826]	(0.985			
M_3	−1.133	−0.144	2.139	1.872	0.581	2.41	0.728	
	[−15.99]	[−10.86]	[1.695]	[3.204]	(0.947)			
M_4	0.736	−0.00709	—	—	0.770	2.31	0.575	
	[28.77]	[−14.33]			(0.933)			
M_5	1.595	−0.00627	0.630	0.560	0.964	2.37	0.524	
	[136.4]	[−28.65]	[2.692]	[3.559]	(0.980)			
M_6	1.542	−0.00551	0.461	0.418	0.969	2.32	0.503	
	[159.9]	[−30.58]	[2.381]	[3.090]	(0.981)			

[a] The coefficients α, β, γ, correspond to those given in equations (1), (2).
[b] The various components of manhours $M_1, \ldots, M_6$ are defined in the second section above.

TABLE XIX

(iii) Tobacco

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	−1.174	−0.0137	0.530	0.627	0.934	1.94	0.417	49:4–69:4
	[−33.35]	[−30.91]	[5.573]	[7.721]	(0.978)			
M_2	−1.297	−0.0122	0.471	0.528	0.925	1.91	0.380	
	[−38.10]	[−28.53]	[5.122]	[6.357]	(0.971)			
M_3	linear equation (see below)							
M_4	−2.432	−0.0108	—	—	0.833	2.28	0.756	
	[−56.54]	[−12.76]			(0.964)			
M_5	−0.924	−0.0133	0.374	0.478	0.926	2.01	0.509	
	[−26.17]	[−29.57]	[3.940]	[6.821]	(0.982)			
M_6	−0.981	−0.0118	0.329	0.386	0.914	1.94	0.507	
	[−28.31]	[−26.77]	[3.461]	[5.604]	(0.978)			

	α_0	α_1	α_2	β_0	β_1	γ_0	γ_1	$\bar{R}^2$	DW	ρ
M_3	0.0478	−0.00111	0.00000627	0.0673	−0.000671	0.0541	−0.00423	0.771	2.05	0.347
	[6.625]	[−5.481]	[4.232]	[3.238]	[−2.066]	[4.420]	[−1.161]	(0.877)		

(iv) Rubber

M_1	−0.667	−0.0102	0.591	0.478	0.584	2.03	0.950	49:4–69:4
	[−7.383]	[−6.257]	[6.713]	[8.746]	(0.984)			
M_2	−0.765	−0.0101	0.524	0.396	0.624	1.98	0.950	
	[−9.653]	[−7.073]	[6.962]	[8.265]	(0.988)			
M_3	−3.311	−0.00696	1.071	1.505	0.378	2.08	0.655	
	[−25.78]	[−2.966]	[2.484]	[4.425]	(0.714)			
M_4	−1.883	−0.00241	0.312	—	0.837	1.01	0.950	
	[−23.07]	[−1.643]	[4.420]		(0.951)			
M_5	−0.413	−0.00772	0.506	0.365	0.692	2.09	0.876	
	[−10.748]	[−10.60]	[7.250]	[8.148]	(0.986)			
M_6	−0.436	−0.00779	0.456	0.283	0.743	2.02	0.891	
	[−12.83]	[−12.12]	[8.051]	[7.867]	(0.991)			

(v) Leather

M_1	−0.501	−0.00445	0.854	0.769	0.859	2.04	0.853	49:4–69:4
	[−18.604]	[−7.017]	[11.138]	[14.587]	(0.993)			
M_2	−0.515	−0.00571	0.676	0.471	0.769	1.78	0.950	
	[−12.291]	[−6.889]	[11.090]	[11.773]	(0.996)			
M_3	linear equation (see below)							
M_4	−1.459	−0.0146	0.313	—	0.605	1.17	0.950	
	[−13.444]	[−0.945]	[2.210]		(0.994)			
M_5	−0.171	−0.00681	0.773	0.683				
	[−6.522]	[−11.375]	[11.690]	[15.240]	0.887	2.35	0.880	
					(0.997)			
M_6	−0.145	−0.00744	0.625	0.397	0.854	1.99	0.950	
	[−5.038]	[−13.045]	[14.914]	[14.408]	(0.999)			

	α_0	α_1	α_2	β_0	β_1	γ_0	$\bar{R}^2$	D.W.	ρ
M_3	0.0154	0.000781	−0.0000081	0.140	−0.00120	0.175	0.833	1.93	0.148
	[4.114]	[3.700]	[−2.964]	[6.871]	[−2.770]	[15.44]	(0.869)		

TABLE XIX

(vi) Textiles

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	0.729	−0.0144	0.947	0.765	0.978	2.21	0.580	51:2–69:4
	[48.85]	[−57.54]	[20.86]	[14.86]	(0.995)			
M_2	0.609	−0.0141	0.916	0.552	0.982	2.18	0.520	
	[46.72]	[−65.13]	[22.91]	[11.19]	(0.996)			
M_3	−1.429	−0.0175	1.254	2.833	0.696	1.96	0.778	
	[−13.52]	[−9.433]	[4.415]	[12.06]	(0.937)			
M_4	−0.979	−0.00719	0.251	—	0.789	2.08	0.815	
	[−26.53]	[−10.83]	[2.857]		(0.969)			
M_5	0.902	−0.0131	0.816	0.643	0.969	2.26	0.713	
	[52.97]	[−44.34]	[16.67]	[14.28]	(0.996)			
M_6	0.847	−0.0128	0.795	0.447	0.980	2.22	0.613	
	[65.59]	[−58.44]	[20.41]	[10.62]	(0.996)			

(vii) Apparel

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	0.568	−0.00284	1.344	0.864	0.853	1.33	0.950	51:2–69:4
	[12.81]	[−3.559]	[14.57]	[13.92]	(0.980)			
M_2	0.558	−0.00318	1.017	0.469	0.847	1.14	0.950	
	[15.26]	[−4.816]	[13.87]	[9.159]	(0.984)			
M_3	linear equation (see below)							
M_4	−0.141	−0.0136	—	—	0.079	1.11	0.950	
	[−1.731]	[−9.428]			(0.991)			
M_5	0.943	−0.00536	1.097	0.866	0.938	1.76	0.950	
	[28.53]	[−8.978]	[15.92]	[18.69]	(0.994)			
M_6	0.999	−0.00569	0.809	0.471	0.961	1.36	0.950	
	[41.97]	[−13.25]	[16.32]	[14.13]	(0.996)			

	α_0	α_1	β_0	β_1	γ_0	$\bar{R}^2$	D.W.	ρ
M_3	0.0431	−0.000516	0.598	−0.00661	0.617	0.641	1.71	0.504
	[7.359]	[−3.074]	[5.683]	[−3.700]	[11.01]	(0.798)		

(viii) Wood

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	0.648	−0.00559	0.935	0.688	0.757	1.68	0.842	49:4–69:4
	[19.02]	[−8.487]	[6.379]	[8.978]	(0.965)			
M_2	0.528	−0.00510	0.836	0.642	0.701	1.71	0.827	
	[15.86]	[−7.911]	[5.480]	[7.937]	(0.955)			
M_3	−1.529	−0.0102	2.168	1.326	0.720	1.82	0.584	
	[−32.90]	[−11.46]	[6.451]	[5.501]	(0.920)			
M_4	−0.554	−0.00784	—	—	0.068	1.70	0.950	
	[−2.907]	[−2.282]			(0.876)			
M_5	0.929	−0.00598	0.850	0.680	0.899	2.14	0.901	
	[31.10]	[−10.52]	[9.209]	[14.75]	(0.985)			
M_6	0.869	−0.00538	0.759	0.637	0.886	2.02	0.872	
	[32.63]	[−10.49]	[7.695]	[12.67]	(0.979)			

TABLE XIX

(ix) Paper

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	0.804	−0.0064	1.072	0.581	0.934	2.24	0.520	51:2–69:4
	[62.53]	[−26.86]	[12.28]	[5.604]	(0.978)			
M_2	0.625	−0.00523	0.816	0.396	0.947	2.04	0.343	
	[73.96]	[−33.23]	[13.80]	[4.314]	(0.974)			
M_3	−0.925	−0.0161	1.803	1.966	0.351	2.33	0.950	
	[−4.125]	[−4.073]	[3.500]	[6.767]	(0.966)			
M_4	linear equation (see below)							
M_5	0.969	−0.00517	0.781	0.481	0.926	2.08	0.950	
	[30.58]	[−9.250]	[10.74]	[11.71]	(0.993)			
M_6	0.836	−0.00370	0.640	0.310	0.927	1.33	0.950	
	[32.44]	[−8.147]	[10.82]	[9.277]	(0.990)			
	α_0	α_1	α_2		$\bar{R}^2$	D.W.	ρ	
M_4	0.233	0.00799	−0.000073		0.359	2.14	0.291	
	[8.955]	[6.333]	[−5.505]		(0.590)			

(x) Printing and Publishing

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	−0.132	−0.00681	0.575	0.367	0.615	2.59	0.859	49:4–69:4
	[−5.420]	[−14.46]	[3.427]	[4.005]	(0.989)			
M_2	−0.218	−0.00593	0.466	0.274	0.482	2.50	0.889	
	[−7.852]	[−11.18]	[2.848]	[3.179]	(0.988)			
M_3	−2.269	−0.0336	1.382	2.564	0.310	2.33	0.896	
	[−6.402]	[−4.975]	[0.690]	[2.447]	(0.920)			
M_4	−0.432	−0.00377	0.384	—	0.311	2.16	0.848	
	[−14.96]	[−6.752]	[2.072]		(0.936)			
M_5	0.449	−0.00609	0.518	0.223	0.730	1.55	0.950	
	[14.87]	[−11.17]	[4.868]	[4.192]	(0.994)			
M_6	0.423	−0.00509	0.410	0.130	0.733	1.11	0.950	
	[15.53]	[−10.35]	[4.266]	[2.708]	(0.993)			

(xi) Metals

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	1.993	−0.00931	1.110	0.721	0.971	1.83	0.764	51:2–69:4
	[91.69]	[−22.90]	[13.51]	[8.120]	(0.992)			
M^2	1.886	−0.00903	1.014	0.575	0.964	1.85	0.775	
	[80.28]	[−20.52]	[11.58]	[6.232]	(0.991)			
M_3	−0.297	−0.01221	2.104	2.478	0.930	2.01	0.492	
	[−12.308]	[−27.27]	[20.67]	[13.60]	(0.982)			
M_4	0.903	−0.00486	0.522	—	0.790	1.85	0.229	
	[50.76]	[−14.80]	[6.890]		(0.843)			
M_5	2.287	−0.00795	0.849	0.629	0.979	2.30	0.901	
	[76.66]	[−14.36]	[10.97]	[10.20]	(0.995)			
M_6	2.244	−0.00755	0.762	0.478	0.962	2.31	0.950	
	[46.61]	[−8.86]	[8.533]	[7.686]	(0.994)			

Table XIX

(xii) Transport

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	0.708	−0.00925	0.851	0.652	0.892	2.19	0.551	51:2–69:4
	[26.59]	[−19.14]	[13.63]	[9.605]	(0.972)			
M_2	0.600	−0.00914	0.750	0.471	0.856	2.07	0.826	
	[17.99]	[−14.99]	[11.81]	[12.44]	(0.990)			
M_3	−1.808	−0.00864	0.878	1.430	0.146	1.89	0.223	
	[−11.721]	[−3.075]	[2.361]	[2.203]	(0.307)			
M_4	linear equation (see below)							
M_5	0.876	−0.00726	0.649	0.482	0.735	1.98	0.529	
	[23.48]	[−10.73]	[7.395]	[4.852]	(0.912)			
M_6	0.852	−0.00727	0.604	0.342	0.814	2.10	0.300	
	[31.65]	[−14.85]	[9.328]	[3.299]	(0.897)			

	α_1	α_2	$\bar{R}^2$	D.W.	ρ
M_4	0.387	−0.000034	0.016	2.12	0.265
	[21.97]	[−0.660]	(0.077)		

(xiii) Non-metallic minerals

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	−0.146	−0.00655	1.129	0.538	0.651	1.92	0.896	51:2–69:4
	[−3.893]	[−9.635]	[10.40]	[8.830]	(0.991)			
M_2	−0.278	−0.00637	0.993	0.421	0.476	1.87	0.950	
	[−4.953]	[−6.503]	[9.112]	[7.464]	(0.992)			
M_3	−2.197	−0.00751	2.073	1.625	0.924	2.10	0.248	
	[−103.8]	[−18.95]	[20.02]	[8.119]	(0.962)			
M_4	−1.092	−0.00749	0.455	—	0.318	2.31	0.950	
	[−8.839]	[−3.466]	[2.153]		(0.966)			
M_5	0.212	−0.00689	0.994	0.469	0.700	1.85	0.950	
	[4.050]	[−7.551]	[9.788]	[8.913]	(0.993)			
M_6	0.122	−0.00648	0.907	0.369	0.655	1.81	0.950	
	[2.579]	[−7.881]	[9.903]	[7.766]	(0.994)			

(xiv) Petroleum and Coal

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	−0.983	−0.0170	0.479	—	0.960	2.06	0.625	51:2–69:4
	[−13.33]	[−41.75]	[3.899]		(0.995)			
M_2	−1.037	−0.0175	0.464	0.159	0.981	2.02	0.535	
	[−57.89]	[−58.73]	[4.561]	[1.832]	(0.996)			
M_3	−3.367	−0.0138	1.498	—	0.747	2.00	0.540	
	[−42.97]	[−10.53]	[3.494]		(0.878)			
M_4	−1.531	−0.00507	0.239	—	0.829	1.45	0.950	
	[−21.21]	[−4.022]	[1.574]		(0.977)			
M_5	−0.564	−0.0103	—	—	0.488	1.84	0.950	
	[−8.952	[−9.265			(0.994)			
M_6	−0.566	−0.0109	0.181	—	0.633	1.659	0.950	
	[−11.320]	[−12.53]	[1.716]		(0.997)			

Table XIX

(xv) Chemicals

	α_0	α_1	β	γ	$\bar{R}^2$	D.W.	ρ	Period
M_1	0.284	−0.0144	0.934	0.529	0.650	1.74	0.950	49:4–69:4
	[5.403]	[−15.240]	[6.781]	[5.703]	(0.998)			
M_2	0.147	−0.0136	0.877	0.446	0.597	1.74	0.950	
	[2.866]	[−14.80]	[6.525]	[4.922]	(0.998)			
M_3	−1.788	−0.0208	1.432	1.359	0.531	2.02	0.950	
	[−13.14]	[−8.486]	[4.017]	[5.656]	(0.992)			
M_4	0.0660	−0.0107	0.596	—	0.406	1.70	0.950	
	[1.474]	[−13.20]	[5.443]		(0.995)			
M_5	0.905	−0.0129	0.863	0.414	0.932	1.30	0.950	
	[30.51]	[−24.10]	[11.09]	[7.887]	(0.999)			
M_6	0.833	−0.0120	0.805	0.330	0.930	1.22	0.950	
	[30.48]	[−24.63]	[11.24]	[6.835]	(0.999)			

(xvi) Miscellaneous

M_1	−0.083	−0.00853	0.647	0.777	0.721	1.79	0.950	51:2–69:4
	[−1.959]	[−11.22]	[7.690]	[10.12]	(0.996)			
M_2	−0.184	−0.00823	0.584	0.620	0.727	1.70	0.950	
	[−4.877]	[−12.16]	[7.795]	[9.079]	(0.997)			
M_3	−2.443	−0.0114	1.119	2.230	0.842	2.02	0.687	
	[−40.70]	[−9.972]	[4.989]	[5.559]	(0.961)			
M_4	−1.035	−0.00457	0.999	—	0.858	2.32	0.736	
	[−33.01]	[−7.537]	[8.832]		(0.973)			
M_5	0.250	−0.00746	0.669	0.649	0.910	2.26	0.828	
	[12.95]	[−20.25]	[10.42]	[7.964]	(0.996)			
M_6	0.214	−0.00720	0.597	0.495	0.935	2.35	0.774	
	[14.03]	[−24.68]	[10.98]	[6.220]	(0.996)			

TABLE XX

Elasticities and Trends

(i) All Manufacturing

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.79	1.09	3.65
M_2 production worker straight-time hours	0.56	1.01	3.38
M_3 production worker overtime hours	3.58	2.21	5.78
M_4 non-production worker hours	0.00	0.31	2.36
M_5 total worker hours	0.67	0.94	3.31
M_6 total worker standard hours	0.43	0.86	3.10

(ii) Food and Beverages

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.36	0.65	2.14
M_2 production worker straight time-hours	0.28	0.70	1.82
M_3 production worker overtime hours	1.87	2.14	5.76
M_4 non-production worker hours	0.00	0.00	2.84
M_5 total worker hours	0.56	0.63	2.51
M_6 total worker standard hours	0.42	0.46	2.20

Table XX

(iii) Tobacco

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.63	0.53	5.48
M_2 production worker straight time-hours	0.53	0.47	4.88
M_3* production worker overtime hours	3.27	3.39	17.41
M_4 non-production worker hours	0.00	0.00	4.32
M_5 total worker hours	0.48	0.37	5.32
M_6 total worker standard hours	0.39	0.33	4.72

(iv) Rubber

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.48	0.59	4.08
M_2 production worker straight-time hours	0.40	0.52	4.04
M_3 production worker overtime hours	1.51	1.07	2.78
M_4 non-production worker hours	0.00	0.31	0.96
M_5 total worker hours	0.37	0.51	3.09
M_6 total worker standard hours	0.28	0.46	3.12

* Elasticities and trends estimated obtained using linear model and evaluated at 60:4.

TABLE XX

(v) Leather

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.77	0.85	1.78
M_2 production worker straight-time hours	0.47	0.68	2.28
M_3* production worker overtime hours	5.13	2.40	0.01
M_4 non-production worker hours	0.00	0.31	5.84
M_5 total worker hours	0.68	0.77	2.72
M_6 total worker standard hours	0.40	0.63	2.98

(vi) Textiles

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.77	0.95	5.76
M_2 production worker straight-time hours	0.55	0.92	5.64
M_3 production worker overtime hours	2.83	1.25	7.00
M_4 non-production worker hours	0.00	0.25	2.88
M_5 total worker hours	0.64	0.82	5.24
M_6 total worker standard hours	0.45	0.80	5.12

* Elasticities and trends estimated obtained using linear model and evaluated at 60:4.

TABLE XX

(vii) Apparel

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.86	1.34	1.14
M_2 production worker straight-time hours	0.47	1.02	1.27
M_3* production worker overtime hours	15.20	6.90	0.51
M_4 non-production worker hours	0.00	0.00	5.44
M_5 total worker hours	0.87	1.10	2.14
M_6 total worker standard hours	0.47	0.81	2.28

(viii) Wood

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.69	0.94	2.24
M_2 production worker straight-time hours	0.64	0.84	2.04
M_3 production worker overtime hours	1.33	2.17	4.08
M_4 non-production worker hours	0.00	0.00	3.14
M_5 total worker hours	0.68	0.85	2.39
M_6 total worker standard hours	0.64	0.76	2.15

* Elasticities and trends estimated obtained using linear model and evaluated at 60:4.

TABLE XX

(ix) Paper

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.58	1.07	2.56
M_2 production worker straight-time hours	0.40	0.82	2.09
M_3 production worker overtime hours	1.97	1.80	6.44
M_4* non-production worker hours	0.00	0.00	−0.88
M_5 total worker hours	0.48	0.78	2.07
M_6 total worker standard hours	0.31	0.64	1.48

(x) Printing and Publishing

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.37	0.58	2.72
M_2 production worker straight-time hours	0.27	0.47	2.37
M_3 production worker overtime hours	2.56	1.38	1.34
M_4 non-production worker hours	0.00	0.38	1.51
M_5 total worker hours	0.22	0.52	2.44
M_6 total worker standard hours	0.13	0.41	2.04

* Elasticities and trends estimated obtained using linear model and evaluated at 60:4.

TABLE XX

(xi) Metals

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.72	1.11	3.72
M_2 production worker straight-time hours	0.58	1.01	3.61
M_3 production worker overtime hours	2.48	2.10	4.88
M_4 non-production worker hours	0.00	0.52	1.94
M_5 total worker hours	0.63	0.85	3.18
M_6 total worker standard hours	0.48	0.76	3.02

(xii) Transportation

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.65	0.85	3.70
M_2 production worker straight-time hours	0.47	0.75	3.66
M_3 production worker overtime hours	1.43	0.88	3.46
M_4* non-production worker hours	0.00	0.00	0.35
M_5 total worker hours	0.48	0.65	2.90
M_6 total worker standard hours	0.34	0.60	2.91

*Elasticities and trends estimated obtained using linear model and evaluated at 60:4

TABLE XX

(xiii) Non-metallic Minerals

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.54	1.13	2.62
M_2 production worker straight-time hours	0.42	0.99	2.55
M_3 production worker overtime hours	1.63	2.07	3.04
M_4 non-production worker hours	0.00	0.46	2.96
M_5 total worker hours	0.47	0.99	2.76
M_6 total worker standard hours	0.37	0.91	2.59

(xiv) Petroleum and Coal

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.00	0.48	6.80
M_2 production worker straight-time hours	0.16	0.46	7.00
M_3 production worker overtime hours	0.00	1.50	5.52
M_4 non-production worker hours	0.00	0.24	2.03
M_5 total worker hours	0.00	0.00	4.12
M_6 total worker standard hours	0.00	0.18	4.36

Table XX

(xv) Chemicals

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.53	0.93	5.76
M_2 production worker straight-time hours	0.45	0.88	5.44
M_3 production worker overtime hours	1.36	1.43	8.32
M_4 non-production worker hours	0.00	0.60	4.28
M_5 total worker hours	0.41	0.86	5.16
M_6 total worker standard hours	0.33	0.81	4.84

(xvi) Miscellaneous

Variable	Short-run elasticity of employment with respect to output	Intermediate-run elasticity of employment with respect to output	Rate of productivity increase, expressed in percentages at annual rates
M_1 production worker total hours	0.78	0.65	3.41
M_2 production worker straight-time hours	0.62	0.58	3.29
M_3 production worker overtime hours	2.23	1.12	4.56
M_4 non-production worker hours	0.00	1.00	1.83
M_5 total worker hours	0.65	0.67	2.98
M_6 otal worker tandard hours	0.50	0.60	2.88

TABLE XXI

Relative Productivity Trends of the Various Labor Inputs in the Different Industries

	M_1	M_2	M_3	M_4	M_5	M_6
High Productivity	Tobacco Textiles Petroleum & Coal Chemicals	Tobacco Rubber Textiles Petroleum & Coal Chemicals	Tobacco Textiles Paper Chemicals	Tobacco Leather Textiles Apparel Wood Non-metallic minerals Chemicals	Tobacco Textiles Petroleum & Coal Chemicals	Tobacco Textiles Petroleum & Coal Chemicals
Medium Productivity	Rubber Metals Transportation Miscellaneous	Metals Transportation Miscellaneous	Food & Beverages Petroleum & Coal	Food & Beverages Metals Petroleum & Coal	Rubber Metals Transportation Miscellaneous	Rubber Leather Metals Transportation Miscellaneous
Low Productivity	Food & Beverages Leather Apparel Wood Paper Printing and Publishing Non-metallic minerals	Food & Beverages Leather Apparel Wood Paper Printing and Publishing Non-metallic minerals	Rubber Leather Apparel Wood Printing and Publishing Metals Transportation Non-metallic minerals Miscellaneous	Rubber Paper Printing and Publishing Transportation Miscellaneous	Food & Beverages Leather Apparel Wood Paper Printing and Publishing Non-metallic minerals	Food & Beverages Apparel Wood Paper Printing and Publishing Non-metallic minerals

chapter five

PRICE BEHAVIOR IN CANADIAN MANUFACTURING

INTRODUCTION

The basic model explaining price behavior in Canadian manufacturing, developed in section four of chapter two, was of the form:

$$\begin{aligned} \ln P_t = {} & d_0 + d_1 \ln(ULC^N)_t + d_2 \ln(Pm)_t + d_3 \ln(Pus.r)_t \\ & + d_4 \ln X_t + d_5 \Delta\ln(ULC^N)_t + d_6 \Delta\ln(Pm)_t \\ & + d_7 \Delta\ln(Pus.r)_t + d_8 \ln P_{t-1} \end{aligned} \tag{1}$$

where

P_t = price index of output at time t

ULC^N_t = normal unit labor costs at time t

Pm_t = price index of purchased inputs at time t

Pus_t = price index of corresponding commodities in the United States at time t

r_t = exchange rate, measured by the price of U.S. dollars in terms of Canadian dollars at time t

X_t = measure of excess demand at time t.

This equation has been estimated for 13 of our 15 major group industries, as well as for all manufacturing level. We do not have price data for the printing and publishing or miscellaneous industries. However, as these industries are very small, our equations cover about 97 per cent of the output of the manufacturing sector.

THE VARIABLES

In this section, we briefly describe the variables used in the empirical estimation. In all cases the construction of the data themselves has involved considerable work, since linking of series available from different sources and over different periods was necessary. In particular, account had to be taken of the change in the SIC which occurred during the sample period. Where appropriate, all raw data have been seasonally adjusted. The details of the data sources and the assembly of the final series are given in the statistical Appendix.

The Price of Output

The dependent variable P_t, measuring the price of output, is the industrial selling price for the corresponding industry. For the period 1956–1969 these data are provided by DBS, although they had to be aggregated to our major group level. Before 1956, the data were taken from the General Wholesale Price Index, aggregated up to the appropriate level and linked to the later series. Details of this procedure are given in the Appendix, section 3.

Normal Unit Labor Costs

Normal unit manhours requirements are derived from the productivity functions reported in chapter four. These are the labor requirements predicted by the total labor productivity functions at full utilization of capacity (and with zero deviation of actual from planned output).

Normal unit labor costs are simply the product of normal manhours requirements and average hourly earnings of all employees in the industry:

$$ULC_t^N = (M_t^e/C_t)W_t$$

where
C_t = capacity output
M_t^e = equilibrium manhours of labor
W_t = average wage rate of all employees.

The productivity functions approximate M_t^e/C_t by a trend and, as discussed earlier (see section three of chapter two), we have fitted both exponential and quadratic trends and have calculated corresponding unit labor costs in each case. In general, the results were very similar and we have chosen one or other as indicated.

The average wage rate for all employees in an industry was obtained by averaging the wage rate for production workers in that industry (measured by average hourly earnings) with the average wage rate of non-production workers. The procedure used to calculate this average measure is described in detail in the Appendix, section 2.

Input Prices

A detailed description of the input price indexes Pm is given in the Appendix, section 3.

At the two-digit industry level these are weighted sums of prices of commodities and services purchased from outside that industry. The weights are based upon the 1961 Input-Output table and are presented in the Appendix. At the all manufacturing level, the input price index is a weighted average of prices of commodities and services purchased outside the manufacturing sector.[1]

One difference between the all manufacturing and industry price indexes should be noted. At the aggregate level all manufactured inputs, including competing imports are netted out. This has not been done at the industry level, because of the fact that separate price data for competitive imports are not generally available. At the industry level, therefore, the effect of changes in the prices of imported manufactured inputs is presumably reflected in the average price of manufactured inputs. For the manufacturing sector as a whole, no allowance is made for these effects. As a result, the coefficient on the U.S. prices in the equation for the sector as a whole may reflect the effects of foreign manufactured prices on unit costs, as well as their influence on entry and demand conditions. At the industry level, these coefficients may be less ambiguously interpreted.[2]

Prices in United States Manufacturing

The U.S. prices at the all manufacturing level were measured by the wholesale price index (WPI) for all manufacturing in the U.S.[3] Prices at the two-digit (SIC) industry level were obtained for the U.S. Where necessary these two-digit prices were aggregated using 1964 import weights to derive the U.S. price for the corresponding major group in Canada. At the industry level, therefore, prices typically represent U.S. price indexes of corresponding manufactured products.

The Exchange Rate

The exchange rate r_t is the price of U.S. dollars in terms of Canadian dollars During the early stages of the study, r_t was measured by the current value of the exchange rate, implying that the elasticity of Canadian prices with respect to U.S. prices is identical to that with respect to the exchange rate. Superior results were obtained by introducing a rather long distributed lag on the exchange rate and we finally settled upon a sixteen-quarter moving average, which has been used in the empirical results that follow. In view of the fact that over much of our sample period Canada was on a floating exchange rate, this seems an appropriate procedure. In general it seems reasonable to assume that firms will respond to the exchange rate which they feel is "permanent" rather than to short run fluctuations and that with a floating rate this will be more accurately measured by some kind of moving average. Moreover, there is evidence to

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1 The fact that intra-sectoral purchases are netted out means that manufactured inputs have small weight in the imput price indexes for the larger sectors, such as foods, and metals, and a zero weight for the manufacturing sector as a whole. This procedure has certain implications for the aggregation of industry equation results which are discussed later in this chapter.

2 See Table XXIX.

3 For a discussion of these series see chapter seven.

suggest that Canadian manufacturers are rather slow to adjust to major re-valuations, so that again a lag on the exchange rate appears to be justified.[4]

Excess Demand

As was discussed in chapter two, we have measured excess demand X_t, by constructing proxy variables for inventory and unfilled orders disequilibria. If an industry produces to stock, we would expect it to respond to an excess demand by running down inventories below some desired equilibrium level; if it produces to order its response would more likely be to increase its backlog of unfilled orders above its equilibrium level. In either case an upward pressure on prices would be exerted.

The following two measures of inventory disequilibrium are used:

(a) H_t/H_t^* where H_t denotes the ratio of total inventories to shipments at time t and H_t^* denotes the equilibirum level of total inventories to shipments, taken to be an eight-quarter moving average of H_t.

(b) FG_t/FG_t^* where FG_t denotes the ratio of finished good inventories to shipments at time t and FG_t^*, the corresponding equilibrium level, is defined to be an eight-quarter moving average of FG_t.

In both cases we make the arbitrary assumption that the equilibrium level can be adequately represented by an eight-quarter moving average of the corresponding variable. Of course it is possible to generate equilibrium levels using more elaborate models of inventory behavior, but such extensions are time consuming and lie beyond the scope of the present study. Moreover, in view of the fact that our results appear to be decidedly superior to those obtained by Courchene (1969), who did estimate equilibrium inventory levels from such models, it seems that there is little to be gained from following such a procedure.

Unfilled orders disequilibrium has been defined analogously,

(c) UO_t/UO_t^* where UO_t denotes the ratio of unfilled orders to shipments at time t and UO_t^* denotes the equilibrium level of unfilled orders to shipments, also measured by an eight-quarter moving average of UO_t.

Because of aggregation, several of the major group of two-digit industries tend to be composed of both industries that produce to stock and those that produce to order, and this is particularly important for larger aggregates such as metal products or manufacturing as a whole. Thus in our empirical work we have introduced (a) and (b) as alternatives, together with (c) for each of the industries. However since this procedure clearly generates a substantial number of combinations of demand variables, we include only that combination in our general equation which turned out to be most satisfactory. As regards signs of the coefficients, it should be clear from the above discussion that the coefficient of $\ln(H_t/H_t^*)$ or $\ln(FG_t/FG_t^*)$ should be negative, and that of $\ln(UO_t/UO_t^*)$ positive.

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[4] See Dunn (1970).

THE EMPIRICAL RESULTS

The results of estimating the general model are given in Table XXII. In all cases the equations were initially estimated using ordinary least squares. However, in view of the consequences of autocorrelation in the presence of a lagged dependent variable, these equations have also been re-estimated using a Hildreth-Lu transformation. The estimate of the first order auto-regressive parameter obtained by applying this transformation is given in the table as ρ; where $\rho = 0$ (such as in industries 02, 03, 08) the results presented are in fact OLS estimates.[5] Since the data for the various series for different industries are available over varying time periods, we have estimated each equation using the maximum number of observations available; the estimation period for each equation is clearly indicated in the table.

In Table XXIII we present our preferred equations. These have been obtained by re-estimating the general models, omitting those variables whose coefficients were statistically insignificant or were of the inappropriate sign. As noted in section six of chapter two, our usual criterion in selecting the preferred equations has been to retain a variable if its coefficient is of the right sign and has a t-ratio of at least unity. Occasionally, where for theoretical reasons we feel that it is appropriate to do so, we include variables whose t-ratios are less than one.

All Manufacturing

The results for the manufacturing sector as a whole are presented at the top of Tables XXII and XXIII. The statistical power of these equations is striking; they account for virtually all of the variation in prices, with the standard error of estimate being about two tenths of one percent. All coefficients have the anticipated sign and most have t-ratios of at least unity. Only the coefficient of the change in unit labor cost has a t-ratio less than one, so this variable has been omitted in the preferred equation.

The dynamic effects on price of the cost and other factors implied by the preferred equation are of particular interest, and are as follows:

Variable	Short-Run Elasticity	Long-Run Elasticity
Unit Labor Costs	0.096	0.434
Materials Costs	0.188	0.161
International Prices	0.431	0.282
Inventories[6]	−0.0413	0.000
Unfilled Orders[6]	0.0318	0.000

[5] It should be noted that in these three cases the Hildreth-Lu procedure indicated that no transformation was necessary.

[6] Long-run effects of a given change in inventories and orders are zero by definition. The long-run effects of a *sustained* disequilibrium in inventories or orders are −0.186 and 0.143 respectively.

Changes in international prices are seen to have a large immediate effect on Canadian manufacturing prices, and a smaller, though still substantial, impact in the long run. For unit labor costs, however, this pattern is reversed, for the short-run elasticity is only one quarter of its long run value. The impact of raw material price changes reveals yet another pattern—the short and long-run effects are of similar magnitude.

These results may be shown to be consistent with economic theory, given certain facts about the typical manufacturing technology. Since output in the manufacturing sector is usually produced under conditions of constant or increasing returns to scale, it follows that the long-run effects of increases in demand upon prices will be zero (unless the elasticity of demand changes with the level of demand). The short-run effect of changes in costs, on the other hand, will depend on the extent to which the costs are shared by actual and potential competitors. If, at a given level of demand pressure, a parallel change in the costs of all actual and potential producers in the market occurs, immediate full forward shifting may occur. The equality of short and long-run effects of purchased input costs—which are dominated by raw materials prices—is hence explainable in these terms.

The contrasting short-run absorption of changes in labor costs can also be explained. In the short run, firms may feel they cannot shift these costs without inducing the entry of new competitors or increasing imports. The resulting decline in profit margins will lead to a slower growth of capacity and output and eventually to price increases—particularly if entrants and potential competitors abroad are seen ultimately to share the initial cost increase.

The effects of the U.S. price changes are more complex, for these can affect domestic prices in three ways. If prices in the U.S. increase, then:

(1) the demand for domestic output will increase;

(2) the elasticity of demand will be reduced; and

(3) to the extent that import prices are reflected in the materials price indexes used, purchased input costs will increase.

With regard to the increase in demand, the short-run effect will exceed the long-run effect for the reason given above. To the extent that wider profit margins induce the entry of new domestic competitors, this will also be true of the effects of any change in the elasticity of demand. Finally, the effects of purchased input costs should—given our results for changes in material prices—be the same in the short run as in the long run. Hence we should expect the short-run effects of changes in international prices to typically equal or exceed their long-run effects—a result consistent with the equation reported above.

Individual Industries

The results for the general model fitted to the industry data are given in Table XXII. As for the manufacturing sector, various measures of excess demand were tried for each industry and we have selected the most successful for Table XXII. In the main, coefficients have their expected signs. Where a coeffi-

cient is highly insignificant or has the wrong sign the corresponding variable has been dropped, resulting in the set of preferred equations reported in Table XXIII. Our discussion of the statistical results shall be confined to these.

Generally speaking, the statistical quality of the industry results in Table XXIII is good. $\bar{R}^2$'s are consistently high, as one would anticipate for equations explaining price levels which include the lagged dependent variable as one of the explanatory variables. The Durbin-Watson statistic—to the extent that it can be relied upon—indicates that the application of the Hildreth-Lu transformation, where it was necessary, eliminates most of the auto-correlation. Only one industry (rubber) is unsatisfactory, but it accounts for only 1.4 per cent of manufacturing output. By contrast, the largest industry, metals, (about 26.3 per cent of manufacturing output) has an excellent equation, and the results for the second largest, food and beverages, are also quite satisfactory.

Normal unit labor costs (ULC^N) are significant in six of the industry equations and marginally significant in two others. In addition $\Delta \ln(ULC^N)_t$ is marginally significant in one other industry, transportation, so that it appears in some form in nine of the 13 industries. Perhaps most surprising is its apparent failure to influence textile prices.

Materials prices are significant in four equations and marginally significant in five others; moreover, $\Delta \ln(Pm)_t$ is marginally significant in two other industries, so that materials prices enter into 11 of the 12 industries for which data are available.[7]

As is evident from the coefficients for U.S. prices, seven of the industries are subject to substantial long-run international linkage effects and short-run effects prevail in three others. However, it is surprising to find that U.S. prices apparently have no effect in the transportation equipment sector. This is hard to accept, since this is one industry in which one would expect international effects to be most important. A large part of the difficulty may be attributed to data limitations. For this industry the U.S. price index represents the price of motor vehicles alone, which is probably an inadequate index for the industry as a whole. Another serious problem is that the impact of the Canada-U.S. Automobile Agreement may have distorted the results. For these reasons this equation should be treated with considerable caution.[8]

As indicated above, excess demand has been measured by either of two measures of inventory disequilibrium and/or unfilled orders disequilibrium. All of these alternatives have been tried for each industry. On theoretical grounds one would expect finished goods inventories to be a better measure of excess demand than total inventories, for the latter include goods in process and may be built up in anticipation of future excess demand, thereby giving a perverse relation-

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7 An adequate input price index could not be constructed for the non-metallic minerals industry.

8 Various attempts were made to take into account the effects of the Canada-U.S. Automobile Agreement. A simple dummy variable was introduced for the period when the agreement is in effect, but was not statistically significant. A price effect variable based on Beigie (1970) estimates of the effects of the Automobile Pact was constructed and introduced, but was also insignificant. In neither instance was the significance of the international price variable increased.

ship between price and excess demand.[9] However, because of aggregation problems at the two-digit level the two measures of inventories were about the same and only in two industries do finished goods inventories lead to superior results.

The best measure of excess demand turned out to be total inventories, which is at least marginally significant in eight industries. Finished goods inventories were significant in the two largest groups, being overwhelmingly so in metals. Finally, unfilled orders were significant in three of the major group industries. Overall, in nine of the 13 industries at least one of the demand variables is at least marginally significant, while in three industries both variables appear to be important. Particularly interesting is the textiles industry, where it appears that prices tend to be predominantly determined by demand conditions. Demand is also important for the metals products group, although costs also tend to play an important role in that sector.

Thus to summarize Tables XXII and XXIII, we may note that all three elements—domestic costs, international prices, demand conditions—play an important role in determining prices. While some of these elements appear to be relatively unimportant in a few individual industries, they are all sufficiently important in sufficiently many industries to enable us to infer their importance in the manufacturing sector overall. These results therefore lend additional support to the aggregate equation where all three effects were found to be important. In Table XXIV we summarize the evidence describing the statistical significance of the various explanatory variables included in the price equations. In this table we do not distinguish between short and long-run significance; if a variable is categorized as having a significant impact this may mean either in the short run, in the long run, or in both.

The short-run and long-run elasticities of price with respect to the various explanatory variables are reported for the preferred equations in Table XXV. Consistent with the aggregate equation, the short-run elasticity with respect to ULC^N is, with few exceptions, low. The only industries where labor costs appear to have a short-run effect of substantial magnitude are wood, metals and, to a lesser extent, non-metallic minerals. In the longer run, labor costs are more fully passed on in the form of higher prices. In addition to the three industries just mentioned, long-run unit labor cost appears also to be important in the apparel and paper industries. As noted above, unit labor costs fail to exercise any significant impact on the textiles prices, while the magnitude of its impact on the transportation equipment industry is also minimal.

As in the manufacturing sector equations, materials prices have a substantially stronger short-run impact on pricing than do unit labor costs. The effect is particularly strong in the tobacco, rubber, leather, metal products and transportation sectors. The long-run responses are substantially stronger than short-run responses in most industries, being especially so in food and beverages, tobacco, rubber, leather textiles and wood. However, three industries—paper,

[9] This could account for the wrong sign on the demand variable for rubber.

transportation equipment and the important metals group—exhibit the opposite pattern. It may appear somewhat surprising that input prices play no role in either the short or long run in apparel and no role in the long run in paper. In apparel a substantial proportion of the inputs of these industries are imported and the weight of their import content may be captured by the corresponding U.S. price. In paper, the problem may be that the market for the product is North American in scope, so that aggregation of the Canadian and U.S. industries may be appropriate. In addition, the input price constructed for this industry is not of high quality.[10]

Short-run international effects are strongest in the rubber, textile, wood and paper industries and are moderate in several others.[11] One apparently curious result is that for wood where the short-run elasticity is 0.89, dropping to zero in the long run. However, since the rate of adjustment of series to cost changes in this industry if only 0.064 per quarter, it would take a long time for the industry to achieve full adjustment, by which time further short-run changes will have occurred.[12] The long-run level of prices appears to be rather strongly linked to international prices in the apparel and metals industries. The high long-run elasticity for non-metallic minerals may in part be serving as a proxy for domestic materials prices, since the data for the latter were unavailable. Moreover the extremely high long-run elasticity for rubber is a consequence of the large value for the coefficient of $\ln P_{t-1}$. However, since the coefficient on $\ln (Pus.r)_t$ in the rubber equation has a t of 0.4, little significance should be attached to this figure.

Demand influences are important for a number of industries as well as for total manufacturing, including the important food and beverage and metal products industries. These variables are also statistically significant for the leather, textiles, wood, paper and transportation equipment industries, and of marginal importance in the tobacco and apparel industries. Only for four industries (rubber, non-metallic minerals, petroleum and coal, and chemicals) were they of no importance at all. It is noteworthy that the latter group are all characterized by at least moderate industrial concentration.[13] On the other hand, the presence of industries of high concentration in the former group suggests that the high level of aggregation we have used precludes our drawing any firm conclusions about the effects of concentration on price behavior in response to demand, at least on the basis of this evidence.

In Table XXVI the various elasticities calculated for the component industries are aggregated (using shipment weights) up to the all manufacturing level and the averages obtained are compared to the corresponding elasticities derived from the equation for the manufacturing sector.[14] While the weighted average of the

[10] See Appendix, section 3.

[11] For each industry the international price variable used is the corresponding U.S. price adjusted by a moving average of the exchange rate. For six industries (02, 04, 05, 06, 07 and 10) a price adjusted for the Kennedy round tariff changes were used as an alternative variable. Because of the modest effects of these tariff changes (refer to ECC study) little change in the equations resulted.

[12] The rate of adjustment implied by equation (1) is of course simply $(1-d_8)$.

[13] See Appendix, section 8.

[14] The shipment weights used are at August 1961 (see Appendix, section 8).

short-run unit labor cost elasticities is practically identical to the corresponding estimate obtained from the all manufacturing, the aggregate of the long-run elasticities is somewhat lower, although the difference is not very large. Note that in both the short run and the long run, the average of the industry input price elasticities exceeds that for all manufacturing while the reverse is true for international prices. The reason for this may be that the industry input price indexes include some imported manufactured goods, whereas these are excluded from the corresponding index for all manufacturing. Finally, while the elasticities with respect to inventory disequilibrium appear to be fairly consistent, the elasticity for unfilled orders obtained via aggregation of the individual industries appears to be rather low. However, this difference may reflect a bias introduced by our selection process. Our preferred equations have been obtained by omitting statistically insignificant variables even where they have the right sign. Since unfilled orders were typically insignificant with a small positive coefficient, deleting it, as we have done in many of the equations, will lead to a downward bias in the average, possibly accounting for the difference between it and the corresponding coefficient for the manufacturing sector equation.

The straightforward aggregation of the individual industry equation results reported in Table XXVI ignores the indirect effects of price increases in one sector via their impact on purchased materials prices in other sectors. However, since the proportion of purchased material inputs which comes from other manufacturing industries is typically small,[15] these indirect effects are not very important. We estimate that with allowance for indirect effects, the short-run elasticity should be adjusted upwards by about five per cent and the long-run elasticities by about six per cent.[16] Adjusted figures for the individual components of total unit labor costs are presented for comparative purposes in the third column of Table XXIX.[17]

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[15] Since the materials prices are net of intra-sector purchases, the importance of purchased manufactured products for large sectors, such as metals and foods, is smaller than for small industries such as tobacco products.

[16] Exact adjustments for indirect effects would require the calculation of the inverse of the matrix $[I - A_{ij}]$ where A_{ij} represents the elasticity of the price of the ith manufacturing industry in response to changes in the price of the jth manufacturing industry, and I is the identity matrix. Lacking estimates of the precise impact of each materials price on each final price, we use the following factor as an approximate adjustment to include allowance for indirect effects when aggregating the individual industry equations:

$$F = \frac{1}{1 - \sum_{i} \varepsilon_{pm,i} \cdot \beta_i \cdot S_i}$$

where $\varepsilon_{pm,i}$ is the elasticity of the ith price with respect to changes in its purchased input price index, β_i is the relative importance of manufactured products in the purchased inputs of the ith industry, and S_i is the fraction of manufactured shipments accounted for by the ith industry. Two adjustment factors were calculated for the short and long-run elasticities respectively. These factors are as follows:

Short run	1.050
Long run	1.057.

[17] The same correction can be easily applied to the short-run inventories and unfilled orders coefficients derived from the aggregation.

Comparison with Previous Studies

There are few published studies of pricing behavior in Canada. At the aggregate level, previous studies explaining the Consumer Price Index have been carried out by Reuber (1964), Vanderkamp (1966), Bodkin, Bond, Reuber and Robinson (1966) and Cragg (1971).[18] In particular, Bodkin *et al.* formulate a model in which the percentage change in the CPI is related to the percentage change in normal unit labor costs (and alternatively average hourly earnings), the percentage change in the implicit deflator for imports, as well as the first two lagged values of the dependent variable. This model is rather different from our levels model and a comparison is difficult, especially since the models have different dependent variables.

Nevertheless, the implied elasticities describing the impact of unit labor costs on prices calculated from their most comparable equation to ours are remarkably consistent with the estimates we obtain. Specifically, they obtain a short-run elasticity of CPI with respect to ULC^N of 0.10 and a long-run elasticity of 0.47, compared with our estimates for the manufacturing sector of 0.10 and 0.43 respectively. In the equation which they themselves regard as the "best", (in which ULC^N is replaced by AHE) these elasticities increase to 0.20 and 1.09 respectively. The latter seems implausibly high but in later variants of this model, both these estimates are reduced to more reasonable magnitudes.

Their short-run import price elasticity (in the equation with unit labor costs) is about 0.08, with the corresponding long-run figure being about 0.5. This result is rather different from ours and the discrepancy is likely accounted for by the fact that they do not include materials prices as a separate independent variable. Finally, they find that various measures of excess demand—one of which is identical to our inventories disequilibrium—do not enter significantly into their equations explaining percentage changes in prices. However, they do indicate that these demand variables occasionally are significant in some price level equations. Thus they conclude that the direct influence of demand factors on price formation is of secondary importance. While our results confirm that cost influences probably dominate, we nevertheless find demand to be significant and important as well.

A recent paper by Courchene (1969) estimates price equations for the manufacturing sector as well as for six selected two and three-digit industries. The emphasis of his study is to determine specifically the impact of excess demand, as measured by inventory disequilibrium, on price movements. He regresses absolute price changes (using quarterly observations) on inventory disequilibrium, changes in wages per hour, changes in corresponding U.S. prices and finally changes in raw materials prices. Since he is explaining first differences and his model includes no lags, his results describe short-run responses. Unfortunately, he does not report elasticities, and since he is working with absolute changes, precise comparison with our findings is again difficult.

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[18] A recent paper by Dunn (1970) also examines in some detail the extent of the link between U.S. and Canadian prices in some selected industries.

However, his results clearly indicate that, for the manufacturing sector, materials prices and U.S. prices tend to be more important than wages in determining price movements, and this is consistent with our short-run results. Moreover, his equations indicate that excess demand is also an important determinant of short-run price changes and this too is in accordance with our findings.

Of his six industry equations, only leather and textiles are directly comparable to ours. Here he finds, as do we, demand to be important in both cases. However, as far as the other variables are concerned, the two studies yield different results. While we find unit labor costs, domestic input prices and international prices all to be significant determinants of leather prices, he finds that wages are insignificant and the latter two variables to be of only marginal importance. On the other hand, in the textile industry we find labor costs to be insignificant, domestic input prices to be significant, and international prices to be marginally significant, whereas Courchene obtains marginally significant labor costs, insignificant raw materials prices and does not introduce U.S. prices. No doubt, the difference in these results can be attributed at least in part to different sample periods.[19]

Courchene also reports results for the heavy transportation, heavy electrical machinery and iron and steel industries, the main finding here being the importance of demand.[20] The first industry is part of our transportation equipment industry while the other two constitute part of the metals group, and we too find prices in both these industries to be sensitive to excess demand. Finally, in both the iron and steel and electrical machinery industries, he finds significant cost effects as well, which is in agreement with our metals equation.

SOME PRELIMINARY TESTS OF ENTRY LIMIT AND TARGET RETURN PRICING

The general model specified above may be viewed as a flexible mark-up model. Flexible, in the sense that prices in the short run may be influenced by demand. Mark-up, in the sense that in the long run, prices are determined completely by unit costs and international prices.

The significance of international prices in a number of sectors and for the manufacturing sector as a whole, however, indicates that a fixed mark-up on unit costs is an inadequate description of pricing behavior in Canadian manufacturing. Rather, we should describe the target profit margin as being itself affected by the condition of entry into the market, with international prices being the main determinant of the entry limiting price.

Given the importance of one variable affecting the entry condition, it is tempting to examine the possible effects of other variables as well. The tradi-

[19] Courchene's analysis extends over the period 1956–62.

[20] Courchene's sixth industry is the refrigerators, vacuum cleaners and appliances.

tional variables originally enumerated by Bain[21]—absolute cost advantages, economies of scale, and product differentiation—appear to be sufficiently stable and sufficiently difficult to measure in a time-series context as to preclude our examining their impact. However, variables which affect the cost of capital to new entrants may also be expected to affect the entry limiting price. For the manufacturing sector as a whole, we examine the effects of two such variables: the rate of interest and the average effective corporate tax rate.[22]

Several arguments can be advanced for the inclusion of capital costs as a determinant of pricing behavior. First, in a concentrated industry which is capital-intensive, capital costs provide a barrier to entry. If capital costs go up and are expected to remain there, an additional umbrella will be provided for the industry to raise prices. Second, higher capital costs in a concentrated industry can lead to a cost-push pressure on prices. Finally, in concentrated industries dominated to a considerable extent by a single firm, it may be in the long-run interests of the firm to a price in a way to liquidate its market share over some specified horizon. An increase in capital costs which are expected to persist would shorten this and lead the firm to increase prices and thus hasten entry.

As a proxy for capital costs we have used a measure of the average corporate bond yields obtained from McLeod, Young and Weir. However, this is rather crude and a more sophisticated measure should attempt to incorporate tax effects in the cost of capital. We therefore make allowance for the effects of changes in tax rates by introducing an eight-quarter moving average of effective corporate tax rates, in order to allow for lags on the part of firms to incorporate tax changes in their pricing decisions. Again one would expect taxes to have a cost-push effect.[23]

Both of these hypotheses are tested in Table XXVII, based on the preferred equation for the manufacturing sector. We have included each of the variables one at a time, as well as including the bond rate and effective tax rates together. The bond rate enters the equation strongly, suggesting that capital costs are indeed important. The effective tax rate is also marginally significant, having the expected sign. It enters more significantly when included with the bond rate, suggesting that a more detailed examination of the role of capital costs may be a fruitful line for further research. Taken together with the more extensive results obtained for international prices, these results indicate that entry limit pricing is of considerable importance in the long run.

We now turn to a consideration of the hypothesis that firms set prices to earn a target rate of return on their financial capital. First, we should emphasize that the general model and preferred results reported above are roughly consistent

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21 See Bain (1956).

22 It would be interesting to examine the effect of detailed changes in the tax structure; however, such an analysis would lead us well beyond the scope of our present study.

23 Furthermore, even though traditional micro economic theory has shown that a monopolist behaving under certainty will not respond to the imposition of a corporate tax, this conclusion no longer applies under uncertainty. There it has been shown that a price setting monopolist will probably set a higher price, thereby passing on some of the effects of the tax. See Penner (1967).

with such behavior when international prices rise at the same rate as domestic costs. This is because the available data indicate that little change in the ratio of financial capital to sales has occurred for these industries over the period of observation. Hence pricing to achieve a constant profit margin on sales (usually described as full cost pricing) is identical with pricing to earn a target rate of return on financial capital under these conditions. Entry conditions permitting—i.e. if international prices rise at the same rate as domestic costs—this is precisely what is implied by our results, since the sum of elasticities on the three cost factors is consistent with the maintenance of unit profits when unit costs increase.

However, another version of the target return pricing hypothesis has recently been developed and tested by Eckstein and Wyss (1971). According to their hypothesis, prices are affected by *actual* profit margins. If margins fall short of the levels required to earn the target rate of return, $\bar{\pi}$ say, prices are increased. If profit margins exceed the level required to achieve the target rate of return, prices are reduced. This hypothesis can be formulated in various ways.

One possible formulation—the one reported here—is to assume that the oligopolist responds to these deviations in profit margins only if they persist for some period of time. Specifically we assume that if $\pi^* > \bar{\pi}$, prices may be lowered, while if $\pi^* < \bar{\pi}$ the opposite adjustment may occur, where π^* denotes an eight-quarter moving average of profits. If $\bar{\pi}$ is assumed to remain constant over the period of estimation then a simple test for the hypothesis is to include π^*, measured by profits after taxes to stockholder's equity, as an additional explanatory variable. As an alternative hypothesis we also tested the possibility that the target rate of return itself is an eight-quarter moving average of actual profits and that firms respond quickly to a disequilibrium by considering the deviation between the current and eight-quarter moving average of profits.

In both tests, the first of which only is reported, the profit variables are insignificant, indicating that this particular version of the target return hypothesis should be rejected. However, as explained above, our results are consistent with the formulation of target return pricing in which firms do not alter their prices in response to cyclical variations in profit rates.

SUMMARY AND CONCLUSIONS

Let us now review the implications of the set of preferred equations. First we consider the implied dynamics of price response. We conclude by commenting further on the implications of these results for the underlying theory of price determination.

As noted above, excess demand plays an important role in several industries. It is instructive to examine the relative sensitivities of prices to changes in demand on the one hand and unit costs on the other. Table XXVIII presents a set of short-run demand response elasticities for the manufacturing sector and for the component major group industries. These elasticities indicate the short-run response in price if an increase in demand (measured by shipments) is met

totally by a drawing down of inventories on the one hand or by an increase in unfilled orders on the other. In either case they presume no production response and therefore indicate the *maximum* short-run response to a one per cent increase in demand if firms respond in either of the two ways mentioned. To the extent that the firm's response to an increase in demand includes *both* a running down of inventories and a lengthening of the backlog of orders, the actual response will be some average of the two reported figures. Table XXIX presents short and long-run response elasticities with respect to changes in total unit costs and their components.

Comparing the figures for all manufacturing, these results indicate that prices are typically less sensitive to changes in demand than they are to changes in unit costs, even in the short run. On the average, a one per cent increase in demand will result in an immediate increase in prices of slightly less than one tenth of one per cent, whereas an increase in unit costs will result in an immediate increase in prices of one third of one per cent. In the long run, a one per cent increase in unit costs will increase prices by six tenths of one per cent, whereas the implied demand effects are zero.

The short-run dynamics of price response to a given shift in demand are also interesting. Based on the aggregate equation for all manufacturing, the maximum response to a change in demand is attained within five quarters following the increase in demand, prices then subsequently gradually decline to their original levels.[24] While this effect is to some extent built into the models via the specification of the form of the demand variables, it is worthwhile noting that this pattern of effects is what would be anticipated under virtually any form of market structure under constant cost conditions. In the long run, prices are determined by unit costs, so that changes in demand can only affect prices in the long run through their effects on unit costs.

As previously noted, unit costs are important for virtually every industry. The pattern of dynamic effects is of particular interest. Confirming the aggregate equation, we find that labor costs are typically absorbed in reduced profit margins in the short run, with their full impact requiring several periods to elapse. The aggregation of the preferred equations reveals that a one per cent increase in unit labor costs will eventually cause an increase in prices of one third of one per cent (which accords very closely with their importance relative to all other costs), although less than a third of this effect is realized in the first quarter following the increase in labor costs.

In contrast, the time pattern of price response to changes in purchased materials prices is very quick. The short-run impact of these prices is about the same as their long-run impact.

The sum of the elasticities on unit materials and unit labor costs indicates the extent to which changes in domestic costs are shifted forward to purchasers

[24] From the first equation of Table XXIII one can calculate that a 0.1 per cent increase in inventories disequilibrium has the following time profile of price changes in the first eight quarters: 0.0413, 0.0682, 0.0841, 0.0912, 0.0915, 0.0867, 0.0778, 0.0657. The responses to changes in unfilled orders disequilibrium have a similar pattern, although the magnitudes are somewhat different.

or are borne in reduced gross profit margins. It is noteworthy that the sum of these elasticities falls somewhat short of the weight of these two cost components in total unit costs, thereby indicating that some portion of an increase in these costs are absorbed in reduced profit margins. While this is particularly important in the short run, some absorption is also implied in the long run. Given the importance of profits and consumer prices in the determination of wages which we reported in chapter three above, this result indicates that there are some built-in stabilizing tendencies which will erode an inflation generated from domestic sources alone. In the absence of changes in the international prices, the strength of the wage-price spiral is vitiated by cost absorption, and a cost inflation will eventually be halted by the squeeze on profit margins which it generates.

When both international prices and domestic costs increase, however, domestic prices rise fast enough to maintain or enhance profit margins. Hence an inflation generated from foreign sources will not have the same self-limiting features as an inflation generated from domestic sources. An inflationary impulse from abroad will tend to widen profit margins, thereby leading to secondary effects on wages. The net effect of such changes will be examined more fully in chapter eight, which discusses international linkages. At this point it suffices to emphasize that, as in the case of wages, the evidence is consistent with a fairly strong and important direct impact of foreign upon domestic prices.

Viewed as a whole, the price results are consistent with the pricing behaviour derived from a flexible target profit margin model. In the short run, prices are influenced by demand conditions in most sectors, and respond somewhat sluggishly to changes in labor costs, indicating that target margin pricing is not rigidly adhered to. In the long run, however, pricing appears consistent with full cost or target return pricing behavior where the target profit margin or rate of return is determined by the conditions of entry into the market. The main variable determining the entry limiting price appears to be the corresponding price abroad. However, the preliminary evidence reported above on the role of interest rates and corporate taxes indicates that factors which influence the cost of capital (and hence the condition of entry) may also affect target profit margins.

TABLE XXII

The General Price Model

Industry	C	$\ln (ULC^N)_t$	$\ln (Pm)_t$	$\ln (Pus.r)_t$	$\ln\left[\frac{H}{H^*}\right]_t$	$\ln\left[\frac{FG}{FG^*}\right]_t$	$\ln\left[\frac{UO}{UO^*}\right]_t$	$\Delta\ln (ULC^N)_t$	$\Delta\ln (Pm)_t$	$\Delta\ln (Pus.r)_t$	$\ln P_{t-1}$	Period	$\bar{R}^2$/D.W.	ρ/se.
All manufacturing†	0.440 [2.456]	0.0956 [3.563]	0.0366 [1.135]	0.0615 [1.827]	−0.0412 [−2.440]	—	0.0315 [1.813]	0.0071 [0.0943]	0.152 [2.247]	0.368 [4.978]	0.779 [10.327]	53:4−69:4	0.999 1.93	0.385 0.0020
01 Food and Beverages	0.667 [1.514]	0.0521 [1.204]	0.178 [2.898]	0.571 [0.952]	—	−0.0422 [−2.210]	—	−0.0983 [−0.486]	0.0020 [0.023]	0.119 [1.500]	0.659 [6.811]	54:4−69:2	0.991 2.01	0.223 0.0067
02 Tobacco	0.140 [0.668]	0.0169 [0.389]	0.0218 [0.509]	0.0277 [0.921]	—	−0.0107 [−0.780]	—	0.0185 [0.367]	0.592 [8.800]	0.0787 [0.801]	0.951 [14.040]	54:4−69:2	0.992 1.88	0.078 0.0074
03 Rubber†	−3.613 [−1.303]	−0.393 [−1.089]	0.879 [1.666]	0.147 [1.230]	0.0318 [1.896]	—	—	0.280 [0.654]	−0.436 [−0.900]	0.0646 [0.211]	0.897 [8.041]	59:4−69:2	0.920 2.08	0.000 0.0154
04 Leather†	0.734 [1.985]	0.0920 [2.257]	0.473 [7.056]	0.120 [1.848]	−0.0141 [−2.307]	—	—	−0.0894 [−3.064]	−0.114 [−1.687]	−0.0042 [−0.103]	0.378 [4.641]	50:4−69:2	0.998 1.99	0.727 0.0086
05 Textiles	0.0577 [0.217]	−0.0199 [−1.184]	0.0094 [0.716]	−0.0267 [−1.374]	−0.0050 [−1.418]		0.0256 [4.079]	0.110 [1.191]	−0.0060 [−0.051]	0.0596 [0.958]	0.982 [17.71]	54:4−69:2	0.999 1.97	−0.223 0.0041
06 Apparel	2.702 [3.204]	0.335 [4.508]	0.0836 [0.638]	0.201 [2.214]	−0.0252 [−2.387]	—	—	−0.242 [−2.533]	−0.483 [−1.968]	−0.277 [−1.034]	0.267 [2.370]	53:4−69:2	0.999 1.93	0.542 0.0057
07 Wood† Industries	0.270 [0.899]	0.0961 [2.412]	−0.0157 [−0.173]	0.0257 [0.435]	−0.0168 [−2.383]	—	−0.0039 [−.176]	0.282 [2.211]	−0.0289 [−0.248]	0.885 [9.489]	0.919 [23.08]	59:4−69:2	0.999 2.07	−0.243 0.0046
08 Paper	2.090 [4.372]	0.224 [4.555]	−0.0841 [−1.930]	0.125 [2.572]	−0.0277 [−2.754]	—	0.0351 [2.202]	−0.261 [−1.900]	0.198 [1.847]	0.365 [4.154]	0.556 [5.102]	59:4−69:2	0.991 2.23	0.000 0.0037
10 Metal† Products	1.100 [4.604]	0.224 [3.068]	0.0238 [0.537]	0.173 [3.698]	−0.0722 [−6.917]	—	0.0201 [2.998]	−0.271 [−7.66]	0.355 [2.246]	−0.0340 [−0.288]	0.608 [8.427]	53:4−69:2	0.997 1.94	−0.135 0.0070
11 Transportation Equipment[a]	0.265 [0.351]	−0.143 [−1.602]	0.443 [2.363]	−0.226 [−1.352]	−0.0047 [−0.404]	—	−0.0048 [−1.295]	0.147 [2.913]	0.290 [0.955]	0.254 [1.250]	0.538 [5.231]	53:4−69:2	0.998 2.07	0.702 0.0097
14 Non-metallic Minerals†	2.073 [3.824]	0.201 [1.429]	N.A.	0.237 [2.299]	—	0.0045 [0.417]	—	−0.0872 [−0.533]	N.A.	−0.0563 [—0.588]	0.525 [4.156]	54:4−69:2	0.999 1.84	0.609 0.0065
15 Petroleum and Coal	2.220 [2.961]	−0.0731 [−0.666]	−0.0230 [−0.174]	0.0881 [1.430]	0.0044 [0.585]		—	0.0803 [0.981]	0.176 [1.615]	0.0234 [1.473]	0.539 [4.302]	54:4−69:2	0.999 2.02	0.898 0.0068
16 Chemicals†	1.643 [3.788]	0.136 [3.022]	0.0683 [1.727]	−0.0093 [−0.155]	—	—	0.0214 [1.144]	−0.110 [−2.171]	−0.115 [−0.645]	−0.350 [−2.213]	0.543 [4.327]	59:4−69:4	0.999 1.85	0.265 0.0024

† Indicates that the ULC^N is based on the exponential trend in the productivity function. In all other cases ULC^N is based on the quadratic trend.

[a] A dummy variable was also added to allow for the effects of the auto pact. It was insignificant and its coefficient is not reported.

N.A. Not Available.

TABLE XXIII

The Preferred Price Equations

Industry	C	$\ln(ULC^N)_t$	$\ln(Pm)_t$	$\ln(Pus.r)_t$	$\ln\left[\frac{H}{H^*}\right]_t$	$\ln\left[\frac{FG}{FG^*}\right]_t$	$\ln\left[\frac{UO}{UO^*}\right]_t$	$\Delta\ln(ULC^N)_t$	$\Delta\ln(Pm)_t$	$\Delta\ln(Pus.r)_t$	$\ln P_{t-1}$	Period	$\bar{R}^2$/D.W.	ρ/se.
All Manufacturing†	0.440 [2.482]	0.0964 [3.793]	0.0357 [1.180]	0.0627 [1.951]	−0.0413 [−2.463]	—	0.0318 [1.887]	—	0.152 [2.273]	0.368 [5.007]	0.778 [10.385]	53:4−69:4	0.999 1.93	0.388 0.0020
01 Food and Beverages	0.551 [1.364]	0.0436 [1.119]	0.184 [3.476]	0.0404 [0.749]		−0.0411 [−2.294]	—	—	—	0.141 [1.927]	0.681 [7.808]	54:4−69:2	0.996 1.99	0.167 0.0066
02 Tobacco	0.0609 [0.702]	—	0.0286 [1.363]	0.0725[a] [2.203]		−0.0133 [−1.055]	—	—	0.583 [10.382]	0.0889[b] [0.948]	0.958 [31.21]	54:4−69:2	0.992 1.86	0.000 0.0072
03 Rubber†	—	—	0.0766 [1.699]	0.0187 [0.374]	—	—	—	—	0.195 [1.049]	0.500 [3.280]	0.923 [20.30]	51:4−69:2	0.859 1.81	0.000 0.0217
04 Leather†	0.706 [2.858]	0.0923 [2.279]	0.475 [7.402]	0.114 [3.110]	−0.0142 [−2.366]	—	—	−0.0896 [−3.098]	−0.115 [−1.729]	—	0.382 [5.555]	50:4−69:2	0.998 1.99	0.728 0.0085
05 Textiles	0.229 [1.446]	—	0.0242 [2.198]	—	−0.0059 [−1.911]	—	0.0228 [4.339]	—	0.114 [1.174]	—	0.926 [22.61]	54:4−69:2	0.994 1.95	−0.089 0.0042
06 Apparel	2.307 [5.866]	0.261 [4.350]	—	0.179 [4.238]	−0.011 [−1.201]	—	—	−0.221 [−2.181]	—	—	0.450 [4.853]	53:4−69:2	0.999 2.00	0.397 0.0059
07 Wood† Industries	—	0.0517 [3.245]	0.0505 [1.505]	—	−0.0142 [−2.433]	—	—	0.238 [2.353]	—	0.885 [12.01]	0.936 [26.42]	59:4−69:2	0.999 2.03	−0.208 0.0044
08 Paper	1.779 [3.398]	0.164[c] [4.105]	—	0.0902 [2.053]	−0.0198 [−2.123]	—	0.0310 [1.933]	—	0.151 [1.473]	0.363 [4.024]	0.559 [5.149]	59:4−69:2	0.991 1.86	0.000 0.0038
10 Metal† Products	0.994 [5.420]	0.205 [3.204]	0.0484 [1.878]	0.146 [4.793]	—	−0.0729 [−8.928]	0.0184 [2.928]	—	0.350 [2.285]	—	0.617 [9.113]	53:4−69:2	0.998 1.93	−0.166 0.0069
11 Transportation Equipment	0.631 [2.475]	0.0086 [0.255]	0.0207 [0.514]	—	−0.0181 −2.170]	—	—	0.0210 [1.866]	0.388 [1.613]	—	0.839 13.94]	51:1−69:2	0.997 2.00	0.427 0.0098
14 Non-metallic Minerals†	1.671 [3.928]	0.157 [1.423]	—	0.196 [2.570]	—	—	—	—	—	—	0.618 [6.190]	54:4−69:2	0.999 1.85	0.535 0.0063
15 Petroleum and Coal	2.189 [3.421]	—	0.112 [1.098]	0.101 [2.176]	—	—	—	0.0320 [0.516]	—	—	0.409 [3.672]	54:4−69:2	0.998 1.80	0.950 0.0068
16 Chemicals†	1.441 [3.301]	0.155 [3.588]	0.0686 [3.684]	—	—	—	0.0144 [0.763]	−0.100 [−1.945]	—	—	0.581 [5.314]	59:4−69:2	0.999 1.91	0.275 0.0024

† Indicates that the ULC^N is based on the exponential trend in the productivity function.
In all other cases ULC^N is based on the quadratic trend.

[a] This is coefficient of $\ln r_t$ alone. $\ln Pus_t$ is suppressed.

[b] This is coefficient of $\Delta\ln Pus_t$ alone. $\Delta\ln r_t$ is suppressed.

[c] This is coefficient of $\ln ULC^N_{t-1}$.

TABLE XXIV

Summary of Evidence Describing Statistical Significance of Explanatory Variables in the Price Equation

	Industry	Unit Labor Cost	Domestic Input Prices	International Prices	Demand
	All Manufacturing	xx	xx	xx	xx
01	Food and Beverages	x	xx	x	xx
02	Tobacco	0	xx	xx	x
03	Rubber	0	x	xx	0
04	Leather	xx	xx	xx	xx
05	Textiles	0	xx	x	xx
06	Apparel	xx	0	xx	x
07	Wood Industries	xx	x	xx	xx
08	Paper	xx	x	xx	xx
10	Metal Products	xx	xx	xx	xx
11	Transportation Equipment	x	x	0	xx
12	Non-metallic Minerals	x	NA	xx	0
15	Petroleum and Coal	—	x	xx	0
16	Chemicals	xx	xx	0	—

xx indicates that the variable is significant (t-ratio greater than 2) in the preferred equation.
x indicates that the variable is marginally significant (t-ratio between 1 and 2).
– indicates that the variable is insignificant (t-ratio less than 1).
0 indicates that the variable is omitted from the preferred equation.

TABLE XXV

Price Elasticities Calculated from Preferred Equations

Industry	ULC^N		Pm		International		Inventories		Unfilled Orders	
	short run	long run	short run	long run	short run	long run	short run	long run	short run	long run
All Manufacturing	0.0964	0.434	0.188	0.161	0.431	0.282	−0.0413	0	0.0318	0
01 Food and Beverages	0.0436	0.137	0.184	0.577	0.181	0.125	−0.0411	0	0	0
02 Tobacco	0	0	0.612	0.681	0.089	0.173	−0.0133	0	0	0
03 Rubber	0	0	0.264	0.994	0.617	0.217	0	0	0	0
04 Leather	0	0.151	0.360	0.769	0.114	0.184	−0.0142	0	0	0
05 Textiles	0	0	0.138	0.327	0.453	0.205	−0.006	0	0.0228	0
06 Apparel	0.041	0.475	0	0	0.179	0.325	−0.011	0	0	0
07 Wood Industries	0.290	0.808	0.0505	0.789	0.885	0	−0.0142	0	0	0
08 Paper	0	0.372	0.151	0	0.453	0.205	−0.0198	0	0.0310	0
10 Metal Products	0.205	0.535	0.398	0.126	0.146	0.381	−0.0729	0	0.0184	0
11 Transportation Equipment	0.030	0.053	0.409	0.130	0	0	−0.0181	0	0	0
14 Non-metallic Minerals	0.157	0.411	0	0	0.196	0.513	0	0	0	0
15 Petroleum and Coal	0.032	0	0.112	0.190	0.101	0.171	0	0	0	0
16 Chemicals	0.055	0.370	0.0696	0.164	0	0	0	0	0.0144	0

Table XXVI

Comparison of Sum of Industry Elasticities, Weighted by Shipment Weights, With All Manufacturing Elasticities

		Sum of Industries	All Manufacturing
Unit labor cost	short run	0.0970	0.0964
	long run	0.324	0.434
Input prices	short run	0.232	0.188
	long run	0.287	0.161
International prices	short run	0.208	0.431
	long run	0.220	0.282
Inventories	short run	−0.0342	−0.0413
	long run	0	0
Unfilled orders	short run	0.0097	0.0318
	long run	0	0

Table XXVII

Additional Price Equations for All Manufacturing

C	$\ln(ULC^N)_t$	$\ln(Pm)_t$	$\ln(Pus.r)_t$	$\ln\left[\frac{H}{H^*}\right]_t$	$\ln\left[\frac{UO}{UO^*}\right]_t$	$\Delta\ln(Pm)_t$	$\Delta\ln(Pus.r)_t$	$\ln P_{t-1}$	$\ln \pi_t^{*a}$	$\ln b_t^b$	$\ln T_t^{*c}$	$\bar{R}^2$/D.W.	ρ/se.
0.372 [1.418]	0.0906 [2.969]	0.0491 [0.958]	0.0424 [0.632]	−0.0403 [−2.352]	0.0299 [1.668]	0.145 [2.016]	0.375 [4.953]	0.792 [9.496]	0.0037 [0.332]			0.999 1.93	0.379 0.0020
0.854 [3.517]	0.0709 [2.752]	0.0447 [1.560]	0.0921 [2.843]	−0.0505 [−3.115]	0.0218 [1.322]	0.136 [2.091]	0.363 [5.206]	0.688 [8.516]		0.0177 [2.416]		0.999 1.90	0.355 0.0019
−0.0869 [−0.172]	0.0902 [3.536]	0.0310 [1.034]	0.0306 [0.727]	−0.0424 [−2.555]	0.0320 [1.911]	0.166 [2.437]	0.365 [5.007]	0.830 [9.623]			0.0187 [1.092]	0.999 1.90	0.370 0.0020
0.174 [0.360]	0.0597 [2.309]	0.0397 [1.423]	0.0515 [1.292]	−0.0531 [−3.347]	0.0207 [1.282]	0.153 [2.348]	0.358 [5.238]	0.749 [8.662]		0.0195 [2.684]	0.0256 [1.588]	0.999 1.87	0.333 0.0019

[a] π_t^* denotes an eight-quarter moving average of after tax profits divided by stockholders' equity.

[b] b_t denotes the average yield on corporate bonds.

[c] T_t^* denotes an eight-quarter moving average of the effective corporate tax rate.

TABLE XXVIII

Short-Run Elasticities of Price With Respect to Demand,
Assuming No Production Response

		Response via Inventories[a]	Response via Unfilled Orders[b]
	All Manufacturing[c]	0.090	0.080
01	Food and Beverages	0.086	—
02	Tobacco	0.031	—
03	Rubber	—	—
04	Leather	0.018	—
05	Textiles	0.007	0.020
06	Apparel	0.013	—
07	Wood	0.019	—
08	Paper	0.029	0.094
10	Metals	0.148	0.007
11	Transportation Equipment	0.026	—
14	Non-metallic Minerals	—	—
15	Petroleum and Coal	—	—
16	Chemicals	—	0.126

[a] This is the elasticity of price with respect to shipments through its effect on the disequilibrium in the inventories-shipments ratio.

[b] This is the elasticity of price with respect to shipments through its effect on the disequilibrium on the unfilled orders-shipments ratio.

[c] All elasticities are obtained from preferred equations reported in Table XXIII.

TABLE XXIX

Alternative Estimates of the Elasticities of Response of Prices to Changes in Unit Costs

Cost Component		Elasticities of Price Response			
		Equation for Manufacturing Sector[a]	Aggregation of Industry Equations: Direct Effects[b]	Aggregation of Industry Equations: Direct & Indirect Effects[c]	Relative Importance of Cost Component in Unit Price[d]
Labor Costs	SR	0.096	0.097	0.102	0.325
	LR	0.434	0.324	0.342	
Purchased Input Costs	SR	0.188	0.232	0.244	0.525[e]
	LR	0.161	0.287	0.303	
Total Costs	SR	0.284	0.329	0.346	0.850[e]
	LR	0.595	0.611	0.645	
International Prices	SR	0.431	0.208	0.218	see note[e]
	LR	0.282	0.220	0.233	
Total Costs and International Prices	SR	0.715	0.537	0.564	0.850[f]
	LR	0.877	0.831	0.878	

[a] Based on the first equation of Table XXIII.

[b] Aggregation (using shipment weights) of industrial elasticities based on the preferred equations reported in Table XXIII.

[c] See footnote 16 above.

[d] The estimates reported in this column are based on data from the 1961 input-output tables [Canada. Dominion Bureau of Statistics. *System of National Accounts: Input-Output Tables. Vol. 1. The Input-Output Structure of the Canadian Economy.* Ottawa, Queen's Printer, 1969. DBS 15-501: Table 1, pp. 262–267]. Intra-sectoral purchases of inputs are excluded.

[e] Purchased inputs include imports of both manufactured and non-manufactured products, since the unit cost effects of changes in input prices for the individual industry equations should be reflected in the price indexes for purchased inputs. The purchased input price index used for the manufacturing equation as a whole, however, excludes the prices of manufactured products, the elasticities of response to input prices may be expected to be lower, and the elasticity of response to international prices higher, than the aggregation of the individual industry results, since the weight of imports of manufactured products in total manufactured unit price is 0.075.

[f] The remaining 0.15 of unit price is accounted for by the gross profit margin.

chapter six

MONEY WAGES IN U. S. MANUFACTURING

As a consequence of the openness of the Canadian economy, wage and price behavior in Canadian manufacturing is influenced to an important degree by developments in the U.S. While Canadian policy-makers are obviously not in a position to influence the movement of prices and wages in the U.S., it is nevertheless clearly in their interest to understand something about how U.S. prices and wages are determined. Such information might permit the anticipation of adverse developments abroad and suitable measures to be taken that offset their effects upon the Canadian economy.

It is primarily with this in mind that we undertake in this and the next chapter analyses of the mechanisms determining wages, prices, and productivity in U.S. manufacturing. Wages are analyzed in this chapter and productivity and prices in the next. In the models of wage and price determination in the U.S., we do not allow for the effects of foreign wages and prices. Otherwise, apart from a few minor departures, the models employed in these two chapters are the same as those used in chapters three to five for Canadian manufacturing. As was the case for Canada, the focus encompasses total manufacturing, and each two-digit manufacturing industry (with exception of ordnance and miscellaneous manufacturing) taken separately. In addition to these two levels of aggregation, results are also presented for the durable and nondurable goods industries treated as groups. The only gap in this coverage occurs in the analysis of output prices where, because of the lack of a comprehensive set of material-prices indexes, equations are not presented for eight of the 19 two-digit industries.

As in our investigation for Canada, the key distinguishing feature of our analysis of U.S. manufacturing money wages is the use of contract weights, the construction of which is described in the Appendix to this chapter. Our intent at the start was to pursue exactly the same procedures as were adopted in chapter three for Canada, but the results so obtained were unsatisfactory, and modifications of the model and its estimation became essential. These modifications are discussed in the first section. In section two, we define the variables used and describe the data. The results are then presented and summarized in sections three through five.

MODIFICATIONS TO THE MODEL

When the wage model used in chapter three was applied to U.S. data, the results left a great deal to be desired. R^2's were uniformly low[1]—even for percentage changes—and wrong signs were frequent. This was true not only for the aggregate equations, but for the majority of two-digit equations as well. In light of this poor performance, some reformulation of the model was clearly necessary, and the following changes were made:

(i) *Contract Spiking*

The first modification was to replace the assumption that in a multiperiod contract wage adjustments are made at the beginning of every quarter with the assumption that they are made the quarter the contract is signed and thereafter only at four-quarter intervals. This is the phenomenon referred to as "spiking" in chapters two. The only exception is where the contract is to expire within two quarters of such an adjustment, in which case no adjustment is assumed to be made. For example, in an 11-quarter contract, adjustments are assumed to occur at quarters 1, 5, and 9. However, if the contract were only 10 quarters instead, adjustments would be assumed to occur at quarters 1 and 5 only. Contract spiking in the real world is obviously not of this rigid a form, but assuming it to be so should not fly too much in the face of reality.

(ii) *Four-quarter Moving Average on Profits and Unemployment*

It was noted in chapter two that negotiated wage changes may depend upon values of the explanatory variables extending over a longer period than just the quarter of signing. In keeping with this, our second modification was to replace the values of unemployment and profits during the current quarter by a moving-average (with equal weights) of the four most recent quarters. However, this was applied only to agreements reached under collective bargaining; current values are retained for the competitive sector and as a measure of wage drift.

[1] In particular, the R^2's were considerably lower than their Canadian counterparts in chapter three. One reason for this may stem from the fact that slightly less 'smoothing" was done at the start with the U.S. wage data. With the U.S. data, two months were averaged to achieve centering, while with the Canadian data, three months were averaged.

(iii) *The Use of Four-quarter Overlapping Changes*

An annoying and frustrating problem frequently encountered in studies in which the variable is a first difference (or percentage change) using quarterly data is very low coefficients of determination (R^2). While frequently a low R^2, with allowance for the nature of the data involved, may be viewed as indicating inadequate performance of the model, in the present circumstances, this inference is not valid. There is little question but that the quarterly wage data being analyzed contain a great deal of noise, and when this is combined with what is probably considerable "legitimate" unexplained variation to begin with, the result is that one has little power to discriminate among models and hypotheses.

Since measurement errors can ordinarily be reduced by averaging, researchers—and we now include ourselves among these—not infrequently turn to four-quarter overlapping differences (which is equivalent to replacing all quantities by four-quarter moving averages). However, while much of the time this procedure does in fact lead to a reduction in errors of measurement and, therefore, to a genuine increase in precision, one must be on guard that the increase is not illusory. If the error term of the model explaining quarterly first differences is truly random, the error term resulting from the implicit aggregation over four quarters in arriving at the model explaining four-quarter overlapping changes will not be, but will show substantial positive autocorrelation. As is well-known,[2] this autocorrelation has two important implications for estimation based on ordinary least squares:

1. The usual formulae for variances and standard errors are biased downward, which means that, on the average, they will understate true standard errors and lead to t-ratios which are biased upward.
2. But even if the correct formulae were used, ordinary least squares is no longer the efficient estimator. Generalized least squares is required in its stead.

To summarize, the use of four-quarter overlapping differences is not in itself to be condemned. If errors of measurement—whether in the dependent variable or the independent variables—are thought to be of consequence, it is a procedure actually to be recommended. However, if the original error term is assumed to be truly random, it should be accompanied by the use of generalized least squares (GLS) in estimation. This we have done.

(iv) *Role of Consumer Prices*

The final modification to the procedures followed in chapter three involves the way that changes in consumer prices appear in the model. Even after the first three modifications were put into effect, changes in the cost of living continued to be of little consequence. This seemed somewhat implausible in

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[2] See Chapter 13 of Malinvaud (1970).

light of the importance attached to the CPI in other recent studies[3] and caused us to consider an alternative representation.

As was noted in chapter two, the effect of changes in the cost of living on money wages is multifaceted. To begin with, there is the effect arising from contracts with escalator clauses. This escalation effect is direct and operates with only a short lag. Next, there is the effect arising from cost of living changes in the past which were not anticipated at the time that contracts were signed. As a result, unions will attempt to restore the previously lost real wage. This effect will tend to occur at the time new contracts are signed—and is probably one of the most important factors making for front-end loading in multi-year contracts. Finally, there is the effect, much emphasized by the accelerationists, which is thought to arise from changes in the cost of living expected in the future.[4]

The first two effects we have dealt with as follows:

1. For the escalator effect, we have included the currently observed change in the CPI weighted by the proportion of production workers currently working under contracts with escalator clauses.
2. For the catch-up effect, we have taken the change in the CPI over the period corresponding to the average length of the contracts which expired last period and which did not have an escalator clause and weighted it by the proportion of production-worker employment accounted for by those contracts.

We shall see that these two procedures lead to markedly improved results.

The third effect, that possibly arising from expectations about inflation in the future, is not included in the results we report below. As already mentioned, we initially followed the procedure adopted in chapter three of including the CPI (contract weighted) with the possible interpretation that it may be serving as a proxy variable for inflationary expectations. However, the initial results thus obtained were very weak, causing us to abandon this specification. While this was somewhat surprising, it nevertheless is consistent with the Turnovsky-Wachter (1972) results obtained for all manufacturing. There it was found that as far as the U.S. is concerned the deviation between actual and expected rates of inflation is a much more important determinant of wage changes than the expectations themselves. This deviation, measuring past prediction errors, is essentially a catch-up effect, so that our present results are consistent with those obtained earlier at the aggregate level.[5]

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[3] See Gordon (1970, 1971), Hymans (1970), and Perry (1966, 1970).

[4] See Friedman (1968), Phelps (1968), and also the discussion in chapters two and three above.

[5] After the empirical results reported in sections three and four incorporating modifications (i)–(iv) were obtained, the equations for all manufacturing, durables, and nondurables were re-estimated employing modifications (ii)–(iv), but not the spiking of (i). The results are little changed, thus indicating that whether uniform or spike weighting is used is not of crucial importance.

The equations (or some version thereof) finally estimated are as follows:

$$\dot{W}_{it} = \alpha + \beta_1 U_t^{-1} + \beta_2 \tilde{U}_t^* + \gamma_1 \pi_{it} + \gamma_2 \tilde{\pi}_{it}^* + \xi_1 \dot{P}_t^* + \xi_2 \dot{\tilde{P}}_t^* + \kappa_1 \ln (W_i/W_T)_{t-1}$$

$$+ \kappa_2 \ln(W_i/W_T)_{t-1}^* + \lambda z_{it} + \varepsilon_{it} \tag{1}$$

$$\dot{W}_{it} = \alpha + \beta_1 \dot{E}_{it} + \beta_2 \dot{\tilde{E}}_{it}^* + \gamma_1 \pi_{it} + \gamma_2 \tilde{\pi}_{it}^* + \xi_1 \dot{P}_t^* + \xi_2 \dot{\tilde{P}}_t^*$$

$$+ \kappa_1 \ln(W_i/W_T)_{t-1} + \kappa_2 \ln(W_i/W_T)_{t-1}^* + \lambda z_{it} + \varepsilon_{it} \tag{2}$$

where:

$\dot{W}_t$ = the within-quarter percent change in average hourly earnings.

U_t = rate of unemployment.

$$\tilde{U}_t^* = \sum_{\tau=0}^{t-n(t)} k_{t,t-\tau} \tilde{U}_{t-\tau}\text{, where}$$

$k_{t,t-\tau}$ = employment weight defined as the ratio of the number of production workers working in quarter t under contracts signed in quarter t-τ (and whose wages are adjusted in t) to production-worker employment in t, and

$$\tilde{U}_t = \left[\frac{1}{4} \sum_{\tau=1}^{4} U_{t-\tau} \right]^{-1}$$

π = profits after federal taxes plus depreciation and depletion as percentage of stockholder's equity.

$$\tilde{\pi}_t^* = \sum_{\tau=0}^{t-n(t)} k_{t,t-\tau} \tilde{\pi}_{t-\tau}\text{, where}$$

$$\tilde{\pi}_t = \frac{1}{4} \sum_{\tau=1}^{4} \pi_{t-\tau}$$

$\dot{P}^*$ = between-quarter per cent change in Consumers Price Index weighted by proportion of production workers currently working under contracts with escalator clauses.

$\dot{\tilde{P}}^*$ = percent change in Consumers Price Index over the period corresponding to the average length of the contracts which expired last period and which did not have an escalator clause weighted by the proportion of production-worker employment accounted for by those contracts.

W = straight-time average hourly earnings.

W_T = straight-time average hourly earnings for all manufacturing.

$$\ln \left(\frac{W_i}{W_T} \right)_{t-1}^* = \ln \sum_{\tau=1}^{t-n(t)} k_{t,t-\tau} \left(\frac{W_i}{W_T} \right)_{t-\tau}$$

$\dot{E}_t$ = between-quarter per cent change in production worker employment.

$$\dot{\tilde{E}}_t^* = \sum_{\tau=0}^{t-n(t)} k_{t,t-\tau}\,\dot{\tilde{E}}_{t-\tau}\text{, where}$$

$$\dot{\tilde{E}}_t = \frac{1}{4}\sum_{\tau=1}^{4} \dot{E}_{t-\tau}$$

z_t = number of production workers reflected in the contract weights, expressed as a per cent of total production-worker employment.

ε_t = random disturbance.

i = subscript identifying industry i.

Remarks:

1. Note that the dependent variable is defined as the *within-quarter* per cent change. Beginning and end of quarter levels were obtained by averaging December-January, March-April, etc.
2. As in chapters two and three, an asterisk means that the corresponding quantity has been contract weighted. Note, however, that since contract spiking is being assumed, $k_{t,t-\tau} = 0$ except for $\tau = 1, 5, 9, \ldots$
3. The determining values for unemployment, employment change, and cash flow are defined as four-quarter moving averages beginning one quarter in the past. This procedure, which corresponds to modification (ii) above, thus assumes that labor and product market conditions for the whole year preceding, not just those prevailing at the time of signing, influence the wage bargain.
4. The last variable, z, is included for purely statistical reasons as an attempt partially to take into account the fact that the weights employed in constructing the contract weighted quantities are based upon an incomplete survey of collective bargaining agreements.

Data

With the exception of the contract weights, which are described in the Appendix to this chapter, the data are from readily accessible published sources. The earnings and employment data are those appearing in *Employment and Earnings, United States, 1909-1970.*[6] For the years prior to 1956 (1959 in the case of motor vehicles), gross AHE have been converted to straight time using the conversion factors appearing on p. 539 of the April 1950 issue of *The Monthly Labor Review*. Unemployment rates are from *Employment and Earnings*, April 1971. Since industry-specific unemployment rates are unavailable prior to 1956 (in some cases prior to 1959) and since an individual industry unemployment rate is a somewhat dubious concept to begin with anyway, the unemployment rate for durable goods manufacturing has been used for the durable goods industries

[6] U.S. Bureau of Labor Statistics. *Employment and Earnings, United States, 1909–1970.* Washington, U.S. Government Printing Office, 1971. (Bulletin No. 1312-7). The data were kindly made available to us prior to publication by BLS.

and the unemployment rate for nondurable goods manufacturing for the nondurable goods industries. Finally, the data on profits, obtained from the Georgetown University data bank, are from the *Quarterly Financial Reports*, published jointly by the Securities Exchange Commission and the Federal Trade Commission. For all models and industries, the data are quarterly and cover the period 1951 through 1969.

EMPIRICAL RESULTS

The empirical results are presented in Table XXX, with seven equations for each industry having been tabulated. Four of these have been estimated uniformly for all industries, namely:

$$\text{(i)}\quad \dot{W}_{it} = \alpha + \beta_1 \tilde{U}_t^{-1} + \gamma_1 \pi_{it} + \xi_1 \, \dot{CPI}_t + \kappa_1 \ln(W_i/W_T)_{t-1} + \varepsilon_{it}$$

$$\text{(ii)}\quad \dot{W}_{it} = \alpha + \beta_2 \tilde{U}_t^* + \gamma_2 \tilde{\pi}_{it}^* + \xi_1 \, \dot{CPI}_t + \kappa_2 \ln(W_i/W_T)_{t-1}^* + \lambda z_{it} + \varepsilon_{it}$$

$$\text{(iii)}\quad \dot{W}_{it} = \alpha + \beta_1 \dot{E}_{it} + \gamma_1 \pi_{it} + \xi_1 \, \dot{CPI}_t + \kappa_1 \ln(W_i/W_T)_{t-1} + \varepsilon_{it}$$

$$\text{(iv)}\quad \dot{W}_{it} = \alpha + \beta_2 \dot{\tilde{E}}_{it}^* + \gamma_2 \tilde{\pi}_{it}^* + \xi_2 \, \dot{CPI}_t + \kappa_2 \ln(W_i/W_T)_{t-1}^* + \lambda z_{it} + \varepsilon_{it}$$

The first equation uses only current values of the predictors, and corresponds to a standard Phillips-curve model with unemployment as the labor market demand variable. The second equation employs the contract-weighted versions of the inverse of unemployment, cash flow, and the relative wage. The third and fourth equations are the same as the first two except that employment change is used in place of unemployment as the labor market demand variable. In these equations, $\dot{CPI}_t$ refers to the currently observed between-quarter per cent change in the Consumers Price Index. The fifth equation selects the "best" performing variables from among equations (i)-(iv), but replaces $\dot{CPI}$ by $\dot{P}^*$ and $\tilde{\dot{P}}^*$ as defined above. The sixth equation is the one ultimately selected as "best", and the seventh is this equation estimated by generalized least squares.

An asterisk on the equation identification numbers in the table indicates that the labor market demand variable is employment change instead of unemployment.[7] All equations have been estimated with the observations expressed as four-quarter changes (or averages, depending upon the variable involved.) As noted above, on the assumption that the original error term is truly random this procedure necessarily introduces positive autocorrelation into the analysis, and for this reason the models finally selected as best have all been re-estimated using GLS.[8] In all cases, the sample period consists of 72 observations, beginning in the first quarter of 1952 and ending in the fourth quarter of 1969. Finally, when U^{-1} and $\tilde{U}^*$ are both in the equation, U^{-1} appears in the form $U^{-1}—\tilde{U}^*$. β_3 is then the coefficient on $\tilde{U}_t^*$ and is equal to $\beta_1 + \beta_2$. The same

[7] There are two instances of equations with double asterisks. These are for industry 21 for which the labor demand variables are $\dot{E}$ and $\tilde{U}^*$ and industry 27 for which the relative wage variable is $\ln(W_i/W_t) - \ln(W_i/W_T)^*$.

[8] The "omega" matrix for the GLS equations has 4's on the main diagonal, the first sub-diagonals above and below the main diagonal have 3's, the second sub-diagonal 2's and the third sub-diagonal 1's. Elsewhere are 0's.

remarks apply to $\dot{E}$ and $\tilde{\dot{E}}^*$ when they are both included, and also to π and $\tilde{\pi}^*$. In the last case, the coefficients are γ_1 and $\gamma_3 = \gamma_1 + \gamma_2$.

For convenience, Table XXXI provides a summary of the statistical performance of the various predictors. One x in this table signifies that the variable has a t-ratio of at least one in the final OLS equation, while two x's signifies that this carries over to the GLS equation as well.

Contract Weighting

As for Canada, there is little question but that the contract-weighted approach leads to results superior to those obtained with the more conventional Phillips curve model. That this is so is clear from a comparison in Table XXX of equations 1 or 3 with equation 6 (in some cases, the comparison is with equation 5). Only for lumber and motor vehicles does contract weighting fail to lead to any noticeable improvement.

Labor and Product Market Variables

From Table XXXI, we find, *a la* Eckstein and Wilson (1962), both labor and product market variables to be important. Labor market variables appear in 18 of the 23 models, while cash flow appears in 12. The current value of the labor market variable is more frequent than its contract-weighted counterpart—indeed, when the latter appears, it is nearly always in conjunction with the former—thus indicating the fairly widespread presence of wage drift and competitive elements. Cash flow, in contrast, almost invariably shows up only in contract-weighted form there being only one instance where the current value appears as well. This is for petroleum, but, as it turns out, the importance of the current value disappears with the application of GLS. Returning to the labor market variables, it is seen that unemployment and employment change appear with about equal frequency with both showing up in the equation for tobacco.

Wrong signs on labor market variables are encountered in electrical machinery, instruments, and tobacco. Interestingly enough, the variable involved is employment change for all three industries. For electrical machinery, the wrong sign is on the deviation of the current value from its contract-weighted counterpart. For tobacco, the negative sign is easily explained, for it reflects the fact that employment variation in this industry—in the U.S., as well as in Canada—typically involves the hiring or laying off of workers of low productivity. However, this does not apply to either of the other industries. For these, the explanation may lie in a backward bending supply curve of effort.

With cash flow, there are also a few instances of wrong signs—most notably in fabricated metals and motor vehicles—but the coefficients are weak statistically and do not carry over to the final equations. Perhaps the biggest surprise regarding this variable is its absence altogether from the final equations for primary metals, electrical machinery, transportation equipment, and motor vehicles taken separately. Indeed, that cash flow should appear in fewer durable goods industries than nondurable is also something of a surprise.

Consumer Prices

As was noted above, changes in the cost of living were first included as simply the currently observed between-quarter percentage change. However, in this form, the CPI, except for lumber, transportation equipment, instruments, and printing,[9] is only a marginal predictor at best, and not infrequently appears with the wrong sign. This result, as already discussed, prompted use of the more elaborate escalator-weighted measures of the change in the CPI. As to performance, there is no question which is the stronger. As can be seen from Table XXXII, which tabulates the coefficients of $\dot{P}^*$ and $\tilde{\dot{P}}^*$ from the GLS equations, the escalator measures appear in 17 of the final OLS equations, and with a t-ratio of at least one in 14 of the GLS equations.[10]

The variable $\dot{P}^*$, it will be recalled, represents the contribution of existing contracts with escalator clauses, and $\tilde{\dot{P}}^*$ the "catch-up" contribution from newly negotiated contracts whose predecessors did not include escalators. While it might be thought that the coefficients on both should approximate one, there are a number of reasons why this might not be the case.

With regard to the coefficient on $\dot{P}^*$, we should note the following:

1. In the first place, ξ_1 should approach one only if escalation is complete, that is, only if there is no limit on the amount that can be escalated. However, most escalator clauses contain ceilings, and the effect of this will be to reduce ξ_1 below one.
2. Secondly, the weights implicit in $\dot{P}^*$ refer only to the unionized sector. Cost of living adjustments presumably occur in the nonunionized sector as well, and since these adjustments are not reflected in the weights in $\dot{P}^*$, they will tend to be picked up in a ξ_1 larger than otherwise.
3. Finally, to the extent that the weights in $\dot{P}^*$ are inaccurate, ξ_1 will be affected accordingly. If, on the average, the weights understate the true proportion of production workers working under escalators, the estimate of ξ_1 will be biased upward and will be biased downward if the reverse is true. Excepting primary metals and motor vehicles, for which our weights are thought very accurate, one of these situations is likely to prevail for any given industry—which it is likely to be, we unfortunately cannot say.

In light of these considerations, the coefficients for $\dot{P}^*$ in Table XXXII present a fairly reasonable picture. The only value clearly out of line is for printing and publishing, and the problem here is most likely one of weights—both inaccuracy with respect to the unionized sector and failure to take into account escalation in nonunion wages. We might have been better advised for this industry, as for

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9 The reference here is to a set of equations which are not included in Table XXX. They are counterparts to equations (6) and (7) except that they include the currently observed per cent change in the CPI instead of $\dot{P}^*$ and $\tilde{\dot{P}}^*$.

10 As is evident from equation (5)* for lumber, the huge coefficient on $\dot{P}^*$ is all out of proportion to anything, and as a consequence the unweighted per cent change in the CPI has been retained in place of $\dot{P}^*$ in equations (6)* and (7)*. The contract weights for lumber are unquestionably among the least accurate in the study, and the problem with $\dot{P}^*$ is thought to stem from this.

lumber, to stick to no weighting at all. The majority of values—in particular, including those for all manufacturing, durables, transportation equipment, and motor vehicles separately—are less than one, which, technical problems of weighting aside, is to be expected in view of the widespread presence of escalator ceilings. The values for primary metals and non-electrical machinery, while both in excess of one, nevertheless cannot be distinguished from one statistically. Neither, for that matter, can the values for nondurables and tobacco, which are also greater than one.

Turning now to the coefficients on $\dot{\tilde{P}}^*$, remarks (2) and (3) for $\dot{P}^*$ are applicable here also, but remark (1) is obviously not relevant. On the other hand, there is a further effect—the tax effect discussed at the end of chapter three—to be taken into account. As was noted in chapter three, with progressive taxation, inflation moves the wage earner into a higher marginal tax bracket, leading him to lose a larger proportion of his income in taxes. He may try to escape the burden of this through a greater money wage, and, to the extent that he succeeds, this will tend to be reflected in a value for ξ_2 greater than one.

However, from the table, we find the values for ξ_2 to be somewhat erratic. The value for textiles seems implausibly large, as it does also, though to a lesser extent, for petroleum. Indeed, of the three ξ_2's with asterisks, only the one for instruments seems reasonable.

However, the most puzzling aspect of the results with respect to $\dot{\tilde{P}}^*$ is the fact that there are quite a number of instances [see equations (5) of Table XXX] where ξ_2 is negative and in addition includes some statistical punch. All manufacturing, durables, nondurables, stone, clay and glass, primary metals, and non-electrical machinery are particular cases in point. $\dot{\tilde{P}}^*$ was dropped from the final equation whenever this occurred, but this procedure, while a short-run statistical palliative, hardly qualifies as the ultimate solution. Multicollinearity of $\dot{\tilde{P}}^*$ with $\tilde{U}^*$ and $\tilde{\pi}^*$ may be part of the explanation, but, given the pervasiveness of the negative ξ_2, there is probably something else as well.

Wage Spillovers

In addition to unemployment and employment change, cash flow, and the cost of living, the lagged relative wage also shows up as an important predictor. There are only six two-digit industries—lumber, transportation equipment, instruments, tobacco, apparel, and printing and publishing—for which this quantity fails to show up in the GLS equation.

There are three industries for which the sign on the lagged relative wage would seem to be wrong, namely, tobacco, printing and publishing, and petroleum. However, it is only for petroleum that this variable appears in the final equation with a positive sign and t-ratio greater than one. For the other two industries, the sign becomes positive only with the application of GLS.

Wage Drift

As already noted, the frequent appearance of both the current and contract-weighted values of the labor market variables suggests a fairly widespread

presence of wage drift. Additional evidence of wage drift is provided by the two instances (apparel and motor vehicles) where the relative wage variable is not contract-weighted.

The Effect of Varying Coverage in the Contract Weights

It will be noted that the variable representing the extent of production-worker coverage in the contract weights appears with a t-ratio > 1 (in absolute value) in 12 of the final equations. While the intended purpose of this quantity is to correct, in some vague way, for the varying coverage of production workers reflected in the contract weights, it is no doubt reflecting other factors as well. If, for example, the coverage of production workers working under agreements established by collective bargaining reflected in the contract weights were complete—which is not the case—then the variable being employed should closely approximate the percentage of an industry's work force which is unionized.[11] A positive sign on λ would then be consistent with the notion that unions possess market power. Accordingly, it is of some interest, though one perhaps should not make too much of it, that 8 of the 12 λ's do turn up positive.

The Use of Generalized Least Squares

Equations 6 and 7 (in a few cases, equations 5 and 6) in Table XXX differ in that equation 7 is estimated by generalized least squares in order to take into account the positive autocorrelation introduced into the error term by the use of four-quarter overlapping percentage changes. As is to be expected, the use of GLS leads to a general reduction in t-ratios—quite substantially in some cases—but the instances are fairly few where statistically importance (on a criterion of 1 standard error) has disappeared altogether. This, needless to say, is reassuring, as is also the fact that, with exception of the two price terms, the GLS coefficients in magnitude are in general quite similar to those in the OLS equation. For ξ_1 and ξ_2, however, the OLS and GLS values in most instances differ markedly. Typically, the GLS values are reduced, frequently to statistical unimportance altogether. In view of the fact that the strongest findings concerning the effect of changes in the cost of living on money wages have typically been found using four-quarter overlapping changes but without the benefit of GLS,[12] this finding is not without its significance.

TRADE-OFFS BETWEEN CHANGES IN MONEY WAGES AND UNEMPLOYMENT

Ever since the pioneering paper of Phillips (1958), a major preoccupation of economists concerned with macroeconomic policy has been the isolation of the

[11] It would not be a complete approximation because of the fact that the coverage implicit in the contract weights refers to the time of contract signing, rather than to the current quarter's employment.

[12] See, in particular, Gordon (1970, 1971) and Perry (1970). Perry employs a correction for first-order autocorrelation. However, with four-quarter changes, the autocorrelation is not first order, but a declining-weight four-quarter moving average. The error introduced by assuming it to be first order is unfortunately not easy to assess.

relationship depicting the trade-offs between changes in money wages and unemployment. Such trade-offs are implicit in all our wage equations in which unemployment appears as a predictor, and our final effort of this chapter shall be to make these explicit. To this end, let us now turn our attention to Table XXXIII where the reader will find calculations referring to two separate points on each of two—a short-run and a long-run—"Phillips" curves.

The short run is defined by the effect on $\dot{W}$ of a change in the *current* level of unemployment, and is measured through the coefficient β_1. The SR Phillips curve thus represents the combined effects on $\dot{W}$ of (1) a change in unemployment in the nonunion sector and (2) to the extent it is reflected in unemployment, wage drift in both sectors, union and nonunion. The long run, on the other hand, is defined as the effect on $\dot{W}$ of a *once-and-for-all* change in unemployment, and is measured through the sum of β_1 and β_2.[13] Defined in this way, the difference between the short run and the long run is thus seen to be that the latter includes the direct contribution of the unionized sector. (Since the current level of unemployment does not enter into the construction of $\tilde{U}^*$, there is no short-run contribution from the unionized sector except that reflected in wage drift.)

The figures in the table refer to the effect on the percentage change in money wages in moving from five per cent unemployment to four per cent and from four per cent to three per cent. That the latter is always the larger is, of course a reflection of the fact that the relationship between $\dot{W}$ and U is postulated as hyperbolic rather than linear.

Looking first at all manufacturing, we see that a decrease in unemployment to four per cent from five per cent implies 0.75 of a percentage point acceleration in $\dot{W}$, while a decrease from four per cent to three per cent implies an acceleration of 1.25 percentage points. This is true of the long run as well as the short run. That there is (virtually) no difference between the long run and the short run follows, obviously, from the fact that β_1 and β_3 are very close in magnitude, which implies that β_2 is close to zero. Since the labor market variable for the durable industries as a group is employment change, a conventional Phillips curve for durables is not defined, but for nondurables, the long-run trade-offs are seen to be about double those in the short run and to be somewhat larger than those for manufacturing as a whole.

As regards the "mini" Phillips curves for individual industries, the "steepest" curves, especially in the long run are seen to be those for textiles, apparel, chemicals, petroleum, and leather—interestingly enough, all nondurable goods industries. In each instance, a movement from four per cent unemployment to three per cent is seen to imply an acceleration in $\dot{W}$ of nearly two percentage points or more. No durable good industry, in contrast, even approaches a long-run trade-off of this magnitude.

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[13] For those industries in which changes in the cost of living appears in the wage equation and standard ULC in the price equation, the long-run Phillips curve should in principle be determined from the reduced form of the price and wage equations. However, for the two industries for which this is the case—textiles and motor vehicles—the feedbacks turn out to be inconsequential in magnitude and thus have been ignored in the calculations.

CONCLUSIONS

The conclusions which emerge from this study of U.S. money wages in manufacturing can be summarized as follows:

1. As we found earlier for Canada, the contract-weighted approach has definite merit and is clearly to be taken seriously.
2. The results strongly confirm the findings of Eckstein and Wilson (1962) that U.S. money wages are influenced by both labor and product market factors.
3. The results also confirm the presence (stressed by Eckstein and Wilson (1962) and also by McGuire and Rapping (1968)) of substantial wage spillover across U.S. manufacturing industries.
4. The impact of changes in the cost of living on U.S. manufacturing wages is quite pervasive, but is seen to operate more through the operation of escalator clauses than as a catch-up for lost real wages resulting from nonescalation in the past.
5. Finally, the results definitely point to a widespread presence of wage drift.

Taken together, these conclusions are very much in keeping with our *a priori* expectations, especially as regards the combined roles of product and labor market conditions, and the pervasiveness of wage spillovers. Moreover, the importance of our findings with respect to contract weighting warrant special emphasis. The substantial predetermined element of the currently observed change in earnings is something which should not be ignored henceforth.

Table XXX

Wage Equations

U.S. Manufacturing Industries

4-Quarter Percentage Changes
(t-ratios in parentheses)

	α	β1	β2	β3	γ1	γ2	γ3	ξ1	ξ2	κ1	κ2	λ	R^2	S.E.	D.W.
All Manufacturing															
(1)	1.203	13.05			−0.0311			0.228					0.556	0.921	0.41
	(0.99)	(6.06)			(−0.38)			(2.83)							
(2)	−6.91		11.129			0.488		−0.0235				0.117	0.571	0.914	0.60
	(−3.55)		(4.35)			(3.92)		(−0.23)				(3.45)			
(3)*	−0.419	0.0587			0.203			0.371					0.360	1.11	0.31
	(−0.30)	(2.10)			(2.42)			(3.81)							
(4)*	−5.91		0.116			0.549		0.0436				0.105	0.486	1.00	0.48
	(−2.57)		(2.18)			(3.94)		(0.39)				(2.85)			
(5)	−3.448	15.43		16.09		0.212		0.711	−1.702			0.176	0.764	0.688	0.90
	(−1.95)	(6.93)		(7.83)		(1.85)		(2.93)	(−2.44)			(5.85)			
(6)	−2.045	13.55		14.77		0.132		0.728				0.128	0.743	0.713	0.81
	(−1.18)	(6.26)		(7.18)		(1.16)		(2.89)				(5.40)			
(7)	−2.230	15.04		14.80		0.155		0.382				0.104	0.721	0.426	GLS
	(−0.73)	(3.64)		(3.16)		(0.77)		(0.94)				(2.32)			
Durable Manufacturing															
(1)	12.87	3.433			−0.0293			0.0970		−145.92			0.565	1.009	0.57
	(3.95)	(1.25)			(−0.39)			(0.93)		(−3.39)					
(2)	6.247		0.472			0.336		−0.0409			−128.99	0.0502	0.598	0.976	0.74
	(1.30)		(0.10)			(3.23)		(−0.38)			(−2.27)	(1.57)			
(3)*	15.19	0.0285			0.0104			0.0934		−180.63			0.570	1.002	0.53
	(6.02)	(1.57)			(0.16)			(0.92)		(−6.29)					
(4)*	−4.098		0.421			0.786		−0.183			58.53	0.168	0.635	0.871	0.55
	(−1.36)		(4.61)			(4.03)		(−1.29)			(2.12)	(3.73)			

(5)*	14.04	0.0737	−0.0737			0.211	0.654	−2.904		−217.93	0.0963	0.764	0.754	0.96
	(4.68)	(5.37)				(2.09)	(3.59)	(−3.43)		(−8.05)	(4.11)			
(6)*	11.17	0.0619	−0.0619			0.179	0.632			−170.21	0.0620	0.721	0.813	0.82
	(3.60)	(4.32)				(1.66)	(3.22)			(−6.80)	(2.71)			
(7)*	14.61	0.105	−0.105			0.180	0.498			−221.72	0.0740	0.683	0.517	GLS
	(2.49)	(4.22)				(0.92)	(1.44)			(1.44)	(1.57)			
24 *Lumber*														
(1)	−1.329	10.15			0.0338		0.433		−7.172			0.357	1.856	1.33
	(−0.91)	(2.44)			(0.30)		(2.58)		(−0.93)					
(2)	−5.460	3.470			0.493		0.0652			−1.760	0.184	0.430	1.760	1.48
	(−3.05)	(1.05)			(4.43)		(−0.30)			(−0.60)	(1.42)			
(3)*	0.749	0.140			0.186		0.606		7.733			0.416	1.769	1.11
	(0.53)	(3.64)			(2.50)		(3.64)		(1.24)					
(4)*	−6.811		−0.135			0.604	−0.166			−1.957	0.178	0.437	1.750	1.49
	(−3.20)		(−1.38)			(4.91)	(−0.53)			(−0.69)	(1.39)			
(5)*	−8.27	0.167	−0.167			0.690	31.83	−0.346				0.572	0.514	1.47
	(−5.84)	(5.05)				(8.51)	(2.24)	(−0.48)						
(6)*	−5.877	0.139				0.548	0.190					0.547	1.547	1.39
	(−4.23)	(4.60)				(5.92)	(1.17)							
(7)*	−5.067	0.264				0.473	0.534					0.482	1.330	GLS
	(−1.57)	(4.92)				(2.26)	(1.32)							
25 *Furniture*														
(1)	−0.980	9.681			0.296		−0.0326		11.15			0.743	0.925	0.83
	(−1.44)	(4.94)			(4.13)		(−0.36)		(2.81)					
(2)	−8.720		5.353			0.662	−0.605			−17.90	0.323	0.651	1.088	0.78
	(−5.50)		(1.73)			(5.56)	(−3.80)			(−5.83)	(4.36)			
(3)*	−0.463	0.0399			0.550	0.711	−0.0559		21.70			0.663	1.059	0.72
	(−0.59)	(1.64)			(9.63)	(5.64)	(−0.54)		(5.23)					
(4)*	−9.087		0.0575			0.274	−0.602			−20.35	0.304	0.639	1.006	0.76
	(−5.27)		(0.88)			(2.65)	(−3.36)			(−7.73)	(6.46)			
(5)	−4.146	13.44		9.431			0.0547	−1.108		−8.311	0.156	0.727	0.975	0.79
	(−2.88)	(5.36)		(3.35)			(0.08)	(−1.04)		(−2.49)	(1.73)			
(6)	−3.233	13.92		10.29		0.212				−5.896	0.0829	0.723	0.969	0.77
	(−3.39)	(5.95)		(3.96)		(2.85)				(−3.07)	(1.66)			
(7)	13.68			15.81		0.176				−3.004	0.0312	0.703	0.609	GLS
	(3.45)			(3.59)		(1.25)				(−1.18)	(0.41)			

For definitions of coefficients, see text.

TABLE XXX—*Continued*

	α	β_1	β_2	β_3	γ_1	γ_2	γ_3	ξ_1	ξ_2	κ_1	κ_2	λ	R^2	S.E.	D.W.
32 *Stone, Clay, and Glass*															
(1)	−3.697	7.385			0.303			−0.0743		−81.51			0.588	1.024	0.62
	(−2.73)	(3.55)			(4.14)			(−0.84)		(−3.20)					
(2)	−2.304		−0.0401			0.290		−0.1434			−213.20	−0.149	0.571	1.052	0.64
	(−1.47)		(−0.01)			(3.66)		(−1.42)			(7.26)	(−3.79)			
(3)*	−3.877	0.0932			0.371			0.105		−129.33			0.580	1.0335	0.53
	(−2.81)	(3.33)			(5.03)			(1.10)		(−6.77)					
(4)*	−1.581		0.0788			0.248		−0.151			−216.68	−0.144	0.587	1.032	0.64
	(−1.06)		(1.61)			(3.05)		(−1.62)			(−8.67)	(−4.68)			
(5)	−5.00	10.57		0.518		0.433		0.823	−1.849		−92.32	−0.0561	0.759	0.80	0.94
	(−3.88)	(5.27)		(0.22)		(6.41)		(4.60)	(−2.97)		(−3.13)	(−1.59)			
(6)	−3.47	11.61				0.340		0.676			−79.47	−0.9034	0.726	0.841	0.85
	(−2.96)	(5.87)				(5.41)		(3.89)			(−3.01)	(−2.91)			
(7)	−2.88	5.34	−5.34			0.289		0.294			−210.71	−0.152	0.648	0.577	GLS
	(−1.05)	(1.69)				(2.00)		(0.79)			(−4.07)	(−2.16)			
33 *Primary Metals*															
(1)	16.87	−5.985			0.0125			0.0444		−60.03			0.348	2.013	0.75
	(4.12)	(−1.46)			(0.11)			(0.25)		(−4.55)					
(2)	10.40		0.807			0.328		0.330			−59.41		0.534	1.714	1.00
	(2.63)		(0.16)			(3.50)		(−1.71)			(−4.89)				
(3)*	11.66	0.0705			0.0444			0.143		−44.39			0.404	1.925	0.44
	(3.43)	(2.94)			(0.42)			(0.83)		(−4.31)					
(4)*	9.459		−0.248			0.443		−0.509			−57.28	0.0720	0.639	1.509	1.17
	(3.55)		(−4.37)			(5.29)		(−3.35)			(−6.22)	(3.59)			
(5)*	21.66	0.125		0.0718				1.230	−2.157		−91.66	0.0805	0.776	1.196	0.89
	(13.75)	(7.56)		(1.36)				(5.31)	(−3.26)		(−11.87)	(4.30)			
(6)*	18.18	0.125		0.0844				1.437			−76.45	0.0844	0.740	1.281	0.73
	(14.64)	(7.08)		(1.49)				(6.03)			(−11.61)	(3.06)			

(7)*	19.75	0.139		0.0520			1.048			−83.31	0.0977	0.706	0.853	GLS
	(7.20)	(7.58)		(0.68)			(2.15)			(−5.74)	(2.66)			
34 *Fabricated Metals*														
(1)	8.162	1.969			−0.0732		0.272		−77.00			0.550	0.997	0.47
	(6.13)	(0.77)			(−1.02)		(2.81)		(−4.87)					
(2)	11.67		3.110		−0.146		0.180			−123.75	−0.0804	0.607	0.938	0.53
	(3.75)		(0.53)		(−0.81)		(1.45)			(−4.16)	(−2.40)			
(3)*	8.533	0.00123			−0.0400		0.263		−84.59			0.546	1.001	0.48
	(6.74)	(0.06)			(−0.68)		(2.60)		(−6.79)					
(4)*	12.36		0.0176			−0.110	0.166			−134.81	−0.0709	0.606	0.940	0.52
	(3.32)		(0.30)			(−0.66)	(1.32)			(−4.60)	(−2.17)			
(5)	10.58						1.177	−0.470		−134.27	−0.0634	0.745	0.765	0.81
	(15.38)						(5.98)	(−0.84)		(−11.03)	(−4.16)			
(6)	10.25						1.149			−129.35	−0.0609	0.732	0.763	0.81
	(17.99)						(5.93)			(−12.15)	(−4.08)			
(7)	11.43						0.865			−149.59	−0.0756	0.717	0.526	GLS
	(8.27)						(2.03)			(−5.76)	(−2.19)			
35 *Non-electrical Machinery*														
(1)	15.27	2.618			0.00304		0.199		−109.76			0.698	0.832	0.45
	(6.76)	(1.14)			(0.05)		(2.16)		(−5.35)					
(2)	17.38		−5.449			0.263	0.0454			−150.16	−0.00952	0.714	0.815	0.49
	(5.46)		(−1.11)			(2.58)	(0.42)			(−5.31)	(−0.25)			
(3)*	17.14	0.00374			0.0505		0.163		−127.66			0.692	0.839	0.46
	(10.25)	(0.28)			(1.35)		(1.86)		(−9.24)					
(4)*	13.44		−0.0573			0.288	−0.0210			−126.56	0.0829	0.721	0.805	0.54
	(6.05)		(−1.72)			(3.16)	(−0.18)			(−8.54)	(1.67)			
(5)	18.05					0.114		−3.513		−147.46	0.144	0.868	0.553	1.07
	(12.43)					(2.92)		(−5.65)		(−14.00)	(5.34)			
(6)	18.25						1.231			−135.61	0.0336	0.803	0.667	0.739
	(14.10)						(8.27)			(−11.95)	(1.53)			
(7)	20.00						1.050			−149.99	0.000107	0.794	0.385	GLS
	(7.50)						(3.91)			(−6.38)	(0.003)			

Table XXX—*Continued*

	α	β_1	β_2	β_3	γ_1	γ_2	γ_3	ξ_1	ξ_2	κ_1	κ_2	λ	R^2	S.E.	D.W.
36 *Electrical Machinery*															
(1)	−5.885	−1.579			0.527			0.272		−4.128			0.525	1.216	0.35
	(−1.54)	(−0.59)			(2.57)			(2.38)		(−0.10)					
(2)	−7.685		−0.227			0.635		0.00157			−13.35	0.0436	0.692	0.987	0.57
	(−1.40)		(−0.07)			(2.07)		(0.01)			(−2.66)	(2.66)			
(3)*	−7.746	−0.0518			0.619			0.226		22.26			0.585	1.137	0.39
	(−2.20)	(−3.18)			(3.19)			(2.10)		(0.63)					
(4)*	8.596		0.214			−0.296		0.00897			−119.16	0.0978	0.868	0.647	0.97
	(2.15)		(9.36)			(−1.34)		(0.13)			(−3.22)	(8.17)			
(5)*	2.92	−0.0141		0.200				0.426	−0.183		−43.50	0.0827	0.897	0.576	1.23
	(17.09)	(−1.57)		(8.28)				(3.06)	(−0.386)		(−3.71)	(10.05)			
(6)*	2.89	0.0149		0.196				0.446			−76.93	0.0808	0.896	0.573	1.22
	(18.72)	(−1.70)		(8.97)				(3.46)			(−2.72)	(12.49)			
(7)*	3.31	−0.0285		0.124				0.176				0.0664	0.875	0.430	GLS
	(8.96)	(−1.51)		(0.273)				(0.57)				(3.97)			
37 *Transportation Equipment*															
(1)	7.757	6.183			−0.0243			0.362		−29.60			0.529	0.984	0.57
	(4.94)	(3.95)			(−0.42)			(4.18)		(−4.03)					
(2)	10.40		3.016			−0.0304		0.461			−43.01	−0.0364	0.551	0.967	0.65
	(4.17)		(1.15)			(−0.13)		(5.16)			(−4.20)	(−2.60)			
(3)*	7.942	0.0313			0.0632			0.513		−34.53			0.469	1.044	0.47
	(4.74)	(2.51)			(1.12)			(6.24)		(−4.39)					
(4)*	11.11		−0.0195			0.0426		0.522			−50.06	−0.0492	0.551	0.967	0.65
	(4.77)		(−1.13)			(0.60)		(6.47)			(−5.31)	(−4.57)			
(5)	14.31	3.693	−3.693					0.882	1.182		−65.31	−0.0233	0.728	0.753	1.07
	(10.86)	(2.20)						(10.33)	(1.07)		(−8.64)	(−2.77)			
(6)	17.56	5.014	−5.014					0.681	0.305		−82.14	−0.0366	0.665	0.564	GLS
	(4.82)	(1.36)						(3.43)	(0.18)		(3.94)	(1.65)			

371	*Motor Vehicles and Parts*													
(1)	8.127	9.658			−0.140		0.478		−19.95			0.558	1.140	1.07
	(3.69)	(4.98)			(−2.26)		(4.80)		(−1.97)					
(2)	3.306		3.903			0.0314	0.596			−1.197	−0.0326	0.494	1.228	1.04
	(3.24)		(1.65)			(−0.56)	(5.53)			(−0.45)	(−2.32)			
(3)*	6.003	0.0601			−0.0567		0.687					0.516	1.192	0.87
	(2.74)	(4.10)			(−0.89)		(7.12)							
(4)*	5.025		0.0326			−0.106	0.658			0.529	−0.0412	0.483	1.242	1.03
	(2.86)		(1.10)			(−1.12)	(6.45)			(0.19)	(−3.15)			
(5)	12.13			6.790			0.818	3.267	−51.38		−0.0351	0.636	1.050	1.48
	(4.99)			(2.87)			(6.54)	(2.08)	(−4.37)		(−2.21)			
(6)	17.34			15.09			0.506	−0.206	−82.36		−0.0217	0.500	1.062	GLS
	(2.30)			(1.90)			(1.25)	(−0.07)	(2.27)		(−0.42)			
38	*Instruments*													
(1)	5.909	1.312			−0.0914		0.387		−90.45			0.577	0.930	0.31
	(7.26)	(0.72)			(−2.52)		(4.47)		(−4.80)					
(2)	7.181		−0.220			−0.125	0.386			−106.24	−0.0807	0.598	0.913	0.36
	(5.13)		(−0.08)			(−1.80)	(4.16)			(−5.14)	(−5.14)			
(3)*	6.089	−0.00490			−0.0791		0.386		−97.02			0.574	0.933	0.31
	(7.75)	(−0.22)			(−2.21)		(4.44)		(−5.96)				0.905	
(4)*	7.409		−0.0459				0.417			−118.44	−0.0889	0.605		0.37
	(5.36)		(−1.11)				(4.51)			(−5.69)	(−1.44)		0.911	
(5)*	4.90	−0.0296					0.282	2.084		−93.74		0.593		0.37
	(15.95)	(−1.45)					(1.01)	(3.59)		(−7.00)			0.461	
(6)*	5.06	−0.0335					0.331	1.108		−93.40		0.579		GLS
	(9.67)	(−1.05)					(0.81)	(1.48)		(−3.97)				

TABLE XXX—*Continued*

	α	β_1	β_2	β_3	γ_1	γ_2	γ_3	ξ_1	ξ_2	κ_1	κ_2	λ	R^2	S.E.	D.W.
Nondurable Manufacturing															
(1)	−4.672	19.02			0.0877			0.182		−29.70			0.498	1.013	0.43
	(−2.01)	(4.44)			(0.60)			(1.46)		(−0.97)					
(2)	−16.84		22.40			0.859		−0.194			−17.62	0.226	0.672	0.826	0.67
	(−5.72)		(5.60)			(4.99)		(−1.47)			(−0.56)	(5.28)			
(3)*	−0.472	−0.104			0.628			−0.0757		69.05			0.380	1.126	0.41
	(−0.20)	(−1.79)			(4.78)			(−0.51)		(2.45)					
(4)*	7.398		−0.0574			0.372		−0.0579			−153.30	0.0470	0.610	0.961	0.76
	(2.47)		(−1.44)			(3.68)		(−0.56)			(−4.99)	(1.81)			
(5)	−10.62	7.842		15.91		0.656		2.160	−3.279			0.252	0.745	0.734	0.86
	(−4.74)	(2.21)		(4.84)		(5.05)		(3.27)	(−4.41)			(6.21)			
(6)	−8.88	8.250		18.03		0.513		0.766				0.151	0.668	0.830	0.62
	(−3.54)	(2.06)		(4.90)		(3.61)		(1.17)				(3.99)			
(7)	−6.22	8.796		16.90		0.365		1.267				0.106	0.661	0.456	GLS
	(−1.54)	(1.28)		(2.34)		(1.54)		(1.42)				(1.67)			
20 *Food*															
(1)	−9.55	6.911			0.468			0.0307		−55.29			0.623	0.895	0.51
	(−2.63)	(1.71)			(0.34)			(0.34)		(−4.58)					
(2)	−29.63		−4.825			1.605		−0.327			−115.51	0.0775	0.705	0.798	0.65
	−(5.38)		(−1.00)			(5.30)		(−2.70)			(−6.71)	(1.23)			
(3)*	−12.90	0.0344			0.696			0.0215		−68.49			0.608	0.914	0.53
	(−3.88)	(0.39)			(4.12)			(0.22)		(−7.24)					
(4)*	−12.22		0.720			0.699		−0.172			−69.42	0.762	0.762	0.717	0.76
	(−2.23)		(4.11)			(2.52)		(−1.57)			(−4.82)	(0.64)			
(5)*	−8.30		0.716			0.471		0.161	−0.028		−62.17		0.764	0.714	0.76
	(−2.35)		(4.03)			(2.64)		(0.42)	(−1.82)		(−6.45)				
(6)*	−6.00		1.795			0.376					−52.81		0.752	0.721	0.75
	(−1.92)		(4.70)			(2.46)					(−6.56)				

(7)*	−17.54		1.737			0.918				−78.64		0.670	0.483	GLS
	(−3.88)		(0.23)			(3.53)				(−5.06)				
21 *Tobacco*														
(1)	−4.89	26.03			0.168		−0.363		2.879			0.169	2.415	0.82
	(−0.18)	(3.38)			(0.87)		(−1.58)		(0.26)					
(2)	−5.637		39.99			0.836	−0.217			−9.037	−0.213	0.318	2.204	0.94
	(−1.87)		(4.54)			(0.48)	(−0.96)			(−4.39)	(−2.60)			
(3)*	4.110	−0.418			0.0787		0.0339		2.589			0.277	2.254	0.53
	(2.24)	(−4.80)			(0.43)		(0.16)		(0.26)					
(4)*	4.962		0.279			−0.0820	0.104			−2.57	−0.0275	0.153	2.456	0.74
	(2.11)		(1.93)			(−0.43)	(0.44)			(−1.40)	(−0.32)			
(5)**	−1.56	−0.354	16.24				0.199	10.37		−6.115		0.644	1.594	0.89
	(−1.10)	(−5.66)	(2.57)				(0.45)	(6.04)		(−5.12)				
(6)**	−1.15	−3.43	20.12				0.934			−5.343		0.447	1.971	0.68
	(−0.66)	(−4.44)	(2.59)				(1.78)			(−3.64)				
(7)**	5.11	−0.455	−0.893				1.182			2.286		0.244	1.424	GLS
	(1.35)	(−5.82)	(−0.05)				(1.01)			(0.85)				
22 *Textiles*														
(1)	−9.854	27.44			0.0817		0.233		−19.6			0.633	1.323	0.61
	(−4.76)	(3.96)			(7.19)		(1.60)		(−3.26)					
(2)	−6.687		22.03			0.286	−0.532			−10.424	0.257	0.725	1.153	0.69
	(4.05)		(3.37)			(3.17)	(−3.29)			(−2.49)	(6.49)			
(3)*	−1.847	0.0890			0.389		0.147		−0.508			0.573	1.425	0.51
	(−1.64)	(2.06)			(5.03)		(0.94)		(−0.12)					
(4)*	−2.10		−0.0179			0.500	−0.585			−1.173	0.255	0.678	1.248	0.61
	(−1.59)		(−0.16)			(4.08)	(−2.72)			(−0.34)	(5.45)			
(5)	−8.08	21.94		24.98			−0.320	2.954		−17.88	0.0911	0.781	1.038	0.69
	(−4.35)	(4.37)		(5.21)			(−0.51)	(3.26)		(−4.48)	(2.42)			
(6)	−8.77	21.15		25.90				2.837			0.0864	0.780	1.032	0.67
	(−6.96)	(4.45)		(5.88)				(3.26)			(2.38)			
(7)	−11.17	11.72		29.97				3.528		−24.39	0.0868	0.759	0.609	GLS
	(−4.52)	(1.38)		(3.61)				(6.09)		(−5.16)	(1.63)			

TABLE XXX—*Continued*

	α	β_1	β_2	β_3	γ_1	γ_2	γ_3	ξ_1	ξ_2	κ_1	κ_2	λ	R^2	S.E.	D.W.
23 *Apparel*															
(1)	−14.11	42.77			−0.186			0.180		−36.22			0.391	2.250	0.44
	(−2.79)	(3.01)			(−0.72)			(0.74)		(−2.08)					
(2)	−3.008		14.19			0.468		−0.173			5.246	−0.00907	0.350	2.325	0.45
	(−0.34)		(0.56)			(1.07)		(−0.52)			(0.18)	(−0.15)			
(3)*	−0.194	−0.260			0.491			−0.179		6.278			0.392	2.248	0.45
	(−0.10)	(−3.04)			(3.95)			(−0.77)		(0.69)					
(4)*	1.290		0.600			0.425		−0.190			9.257	0.0476	0.436	2.182	0.45
	(0.63)		(3.05)			(2.46)		(−0.83)			(0.91)	(0.80)			
(5)	−11.62	17.17		35.27				1.078	0.452	−25.32			0.441	2.172	0.47
	(−3.05)	(1.80)		(2.95)				(1.28)	(0.26)	(−3.67)					
(6)	−11.18	17.58		34.70				1.155		−24.38			0.441	2.157	0.48
	(−3.32)	(1.88)		(2.98)				(1.48)		(−4.20)					
(7)	−10.36	16.66		35.81				0.599		−21.45			0.436	0.1225	GLS
	(−1.68)	(0.99)		(1.63)				(0.42)		(−1.93)					
26 *Paper*															
(1)	−4.915	8.405			0.413			0.0232		−21.72			0.595	0.755	0.80
	(−3.59)	(3.20)			(4.23)			(0.31)		(−4.72)					
(2)	−8.296		1.802			0.672		−0.0902			−49.95	−0.164	0.772	0.570	1.39
	(−7.33)		(0.64)			(8.56)		(−1.46)			(−6.77)	(−5.53)			
(3)*	−5.953	0.111			0.554			0.123		−23.20			0.574	0.773	0.83
	(−4.32)	(2.55)			(6.34)			(1.47)		(−4.77)					
(4)*	−9.037		−0.0436			0.738		−0.110			−53.47	−0.181	0.773	0.569	1.38
	(−6.55)		(−0.86)			(8.16)		(−1.61)			(−8.90)	(−7.34)			
(5)*	−9.22		0.0503			0.739		−0.709	−0.392		−51.97	−0.149	0.797	0.542	1.52
	(8.62)		(1.49)			(11.17)		(−0.98)			(−9.15)	(−5.70)			
(6)*	−8.218		0.0763			0.667					−52.53	−0.163	0.786	0.548	1.50
	(−8.93)		(2.61)			(12.31)					(−9.16)	(−6.99)			

(7)*	−7.493 (−3.10)		0.0644 (1.03)			0.619 (4.41)				−56.55 (−3.27)	−0.176 (−2.69)	0.782	0.452	GLS
27 *Printing and Publishing*														
(1)	0.552 (0.32)	14.80 (5.02)			−0.0829 (−1.22)		0.408 (5.98)		3.769 (0.69)			0.653	0.758	0.93
(2)	−2.121 (−1.18)		18.59 (5.23)			0.0351 (0.34)	0.378 (5.11)			4.299 (0.69)	0.0349 (0.39)	0.731	0.673	1.07
(3)*	−3.894 (−1.82)	−0.0817 (−0.88)			0.173 (2.26)		0.540 (7.15)		20.16 (3.21)			0.528	0.884	0.67
(4)*	−0.203 (−3.56)		−0.268 (−1.90)			0.569 (4.91)	0.278 (3.23)			16.87 (2.14)	0.297 (3.29)	0.639	0.779	0.76
(5)**	−0.661 (−1.31)	3.054 (1.41)		18.46 (6.90)			1.140 (4.39)	1.565 (2.72)	−68.67 (−2.62)	68.67		0.790	0.594	1.39
(6)**	0.662 (0.49)	−0.633 (−0.10)		12.96 (1.84)			1.629 (2.78)	0.482 (0.46)	2.231 (0.07)	−2.231		0.703	0.452	GLS
28 *Chemicals*														
(1)	1.271 (1.10)	8.337 (2.67)			0.255 (3.09)		−0.0116 (−0.15)		−46.56 −(0.32)			0.635	0.885	0.47
(2)	−1.238 (−0.50)		7.100 (1.34)			0.444 (4.81)	−0.0735 (−0.83)			−57.52 (−2.89)	−0.0129 (−0.23)	0.642	0.883	0.51
(3)*	1.368 (1.09)	0.0245 (0.59)			0.355 (4.60)		0.0637 (0.93)		−54.45 (−9.24)			0.598	0.929	0.47
(4)*	0.957 (0.51)		0.0389 (0.634)			0.477 (5.36)	−0.100 (−1.11)			−75.84 (−5.71)	−0.0588 (1.43)	0.634	0.892	0.50
(5)	0.803 (0.44)	6.239 (1.34)		4.346 (0.90)		0.339 (3.52)	1.000 (1.03)	−1.212 (−1.26)		−52.85 (−7.84)		0.670	0.855	0.57
(6)	−0.488 (−0.37)	8.645 (2.17)		7.713 (2.15)		0.366 (4.13)				−51.28 (−7.82)		0.662	0.852	0.51
(7)	−1.067 (−0.30)	9.295 (1.02)		41.75 (1.37)		0.330 (1.45)				−49.66 (−3.03)		0.652	0.621	GLS

TABLE XXX—*Concluded*

	α	β_1	β_2	β_3	γ_1	γ_2	γ_3	ξ_1	ξ_2	κ_1	κ_2	λ	R^2	S.E.	D.W.
29 *Petroleum*															
(1)	−3.374	9.942			0.612			−0.152		−26.73			0.370	1.790	0.81
	(−0.46)	(1.17)			(3.97)			(0.96)		(−1.09)					
(2)	−5.734		−13.20			0.729		−0.0672			−7.73	−0.0178	0.200	2.038	0.840
	(−2.15)		(−0.69)			(2.57)		(−0.35)			(−3.27)	(−1.02)			
(3)*	−0.0219	0.124			0.624			−0.0771		−32.68			0.392	1.758	0.78
	(−0.004)	(1.97)			(4.31)			(−0.498)		(−1.84)					
(4)*	−8.494		−0.204			0.756		−0.0923			−10.09	−0.00948	0.212	2.017	0.844
	(−2.43)		(−1.36)			(3.53)		(−0.48)			(−3.32)	(−0.64)			
(5)	−9.47	25.62			0.961		0.248	2.517	1.335		8.440	0.0237	0.428	1.745	0.84
	(−2.96)	(3.09)			(3.85)		(1.26)	(0.46)	(1.60)		(2.32)	(1.44)			
(6)	−10.26	26.72			0.945		0.290		1.425		7.865	0.0259	0.426	1.735	0.84
	(−3.83)	(3.39)			(3.85)		(1.66)		(1.77)		(2.31)	(1.66)			
(7)	−8.18	27.61			0.289		0.317		1.756		2.274	−0.00998	0.301	1.269	GLS
	−1.11	(1.62)			(0.67)		(0.77)		(2.17)		(1.20)	(−0.34)			
30 *Rubber*															
(1)	−6.059	15.91			0.265			0.583		33.71			0.446	1.508	0.69
	(−2.06)	(2.59)			(1.38)			(3.75)		(3.86)					
(2)	−10.88		6.046			0.710		0.247			−13.88	0.201	0.619	1.260	0.96
	(−4.30)		(1.07)			(4.03)		(1.84)			(−5.43)	(3.01)			
(3)*	−8.133	0.0687			0.531			0.669		32.21			0.446	1.508	0.55
	(−2.81)	(2.57)			(3.27)			(4.12)		(3.78)					
(4)*	−13.34		−0.0406			0.926		0.178			−15.65	0.0871	0.618	1.261	0.93
	(−4.62)		(−1.02)			(5.28)		(1.20)			(−5.60)	(1.53)			
(5)*	−13.77	0.0850				0.936		−1.467	0.964		−16.15	0.114	0.685	1.155	0.83
	(−5.95)	(3.78)				(7.23)		(−0.33)	(1.89)		(−7.82)	(6.07)			
(6)*	−14.08	0.0878				0.951			0.952		−16.21	0.115	0.684	1.147	0.82
	(−6.73)	(4.23)				(7.94)			(1.88)		(−7.95)	(6.25)			

(7)*	−12.42	0.169			0.850		0.805		−13.47	0.120	0.577	0.802	GLS
	(−2.88)	(5.54)			(3.53)		(1.34)		(−3.29)	(2.90)			
31 *Leather*													
(1)	−4.693	20.51		0.215		0.131		−4.213			0.550	1.335	0.49
	(−2.35)	(3.64)		(2.55)		(1.12)		(−0.64)					
(2)	−10.47		26.61		0.231	−0.252			−22.77	0.201	0.574	1.308	0.51
	(−3.24)		(3.19)		(2.63)	(−1.39)			(−2.33)	(3.01)			
(3)*	0.204	0.0398		0.437		0.283		9.126			0.466	1.453	0.46
	(0.13)	(0.85)		(6.49)		(2.27)		(1.53)					
(4)*	−2.010		0.248		0.313	0.226			−4.741	0.0871	0.560	1.330	0.53
	(−1.28)		(2.79)		(4.16)	(1.31)			(−0.73)	(1.53)			
(5)*	−6.61	21.50			0.211	−0.0777	−1.095		−12.32	0.127	0.616	1.251	0.57
	(−3.35)	(4.28)			(2.67)	(−0.04)	(−1.08)		(−1.88)	(1.97)			
(6)*	−6.469	−6.469			0.226				−11.30	0.0932	0.609	1.243	0.55
	(−3.42)	(−3.42)			(2.98)				(−1.75)	(2.46)			
(7)*	−7.662	22.77			0.149				−16.93	0.0977	0.603	0.693	GLS
	(−1.98)	(2.53)			(1.04)				(−1.29)	(1.41)			

Notes: (1) An asterisk on the equation denotes that the labor market variable is employment change.
(2) For industry 24, $\dot{CPI}$ is used in place of $\dot{P}^*$.
(3) For industry 21, the labor market variables are $\dot{E}-\dot{E}^*$ and $\tilde{U}^*$.
(4) For industry 27, the relative wage variable is $\ln(W_i/W_T)-\ln(W_i/W_T)^*$

Table XXXI

Summary of U.S. Wage Models
Final OLS and GLS Equations

Industry	Labor Market		Cash Flow		Relative Wage		CPI			
	current	wtd	current	wtd	current	wtd	$\dot{P}^*$	$\dot{\tilde{P}}^*$	R^2	S.E.
all man.	xx	xx		x			x		0.721	0.43
durables	xx			x		xx	xx		0.683	0.52
24	xx			xx			xx		0.482	1.33
25	xx	xx		xx		xx			0.703	0.61
32	xx			xx		xx	x		0.648	0.58
33	xx	x				xx	xx		0.706	0.85
34						xx	xx		0.717	0.53
35						xx	xx		0.794	0.39
36	xx	xx				xx	x		0.875	0.43
37	xx					xx	xx	x	0.665	0.56
371	xx	xx			xx		xx	x	0.501	1.06
38		xx				xx	x	xx	0.579	0.46
nondurables	xx	xx		xx			xx		0.661	0.46
20				xx		xx			0.670	0.48
21	xx	x				x	xx		0.244	1.42
22	xx	xx				xx		xx	0.759	0.61
23	x	xx			xx		x		0.436	1.22
26		xx		xx		xx			0.782	0.45
27	x	xx			x		xx	x	0.703	0.45
28	xx	xx		xx		xx			0.652	0.62
29	xx		x	x		xx		xx	0.301	1.27
30	xx			xx		xx		xx	0.577	0.80
31	xx			xx		xx			0.603	0.69

Notes: (1) one x indicates a t-ratio ≥ 1 in final OLS equations, two x's a t-ratio ≥ 1 in GLS equation.
(2) For industry 24, $\dot{CPI}$ is used in place of $\dot{P}^*$.

TABLE XXXII

U.S. Wage Models

Changes in the Cost of Living

Coefficients from GLS Equations

industry	$\dot{P}^*$	$\dot{\tilde{P}}^*$
all man.	0.38	—
durables	0.50*	—
24	0.54*	—
25	—	—
32	—	—
33	1.05*	—
34	0.87*	—
35	1.05*	—
36	0.18	—
37	0.68*	0.31
371	0.51*	−0.21
38	0.33	1.11*
nondurables	1.27*	—
20	—	—
21	1.18*	—
22	—	3.53*
23	0.60	—
26	—	—
27	1.63*	0.48
28	—	—
29	—	1.76*
30	0.80*	—
31	—	—

Note: An asterisk indicates a t-ratio $\geq$ 1.

Table XXXIII

Effect on $\dot{W}$ of One Percentage Point Change in the Unemployment Rate
U.S. Manufacturing
(GLS equations)

	short run		long run	
industry	5% → 4%	4% → 3%	5% → 4%	4% → 3%
all man.	0.75	1.25	0.74	1.23
durables	—	—	—	—
24	—	—	—	—
25	0.68	1.14	0.79	1.32
32	0.05	0.44	0	0
33	—	—	—	—
34	0	0	0	0
35	0	0	0	0
36	—	—	—	—
37	0.25	0.42	0	0
371	0	0	0.75	1.26
38	—	—	—	—
nondurables	0.44	0.73	0.85	1.41
20	0	0	0.09	0.14
21	—	—	−0.04	−0.07
22	0.59	0.98	1.50	2.50
23	0.83	1.38	1.79	2.98
26	—	—	—	—
27	−0.03	−0.05	0.65	1.08
28	0.46	0.77	2.09	3.48
29	1.38	2.30	1.38	2.30
30	—	—	—	—
31	1.14	1.90	1.14	1.90

Notes: (1) short run: U^{-1} changes, but not $\tilde{U}^*$
long run: U^{-1} and $\tilde{U}^*$ change by same amount
(2) — denotes that labor market variable is employment change.

Appendix

CONSTRUCTION OF CONTRACT-EMPLOYMENT WEIGHTS FOR U.S. MANUFACTURING*

The contract-employment weights used in this chapter are based upon individual contracts, the details of which are published by the U.S. Bureau of Labor Statistics in a monthly wage chronology in *Current Wage Developments*. For each and every contract listed for firms in the manufacturing industries, the following information was obtained:

(1) effective date of contract

(2) length of the contract

(3) number of employees covered

(4) whether or not the contract contained a cost-of-living escalator clause.

Altogether some 20,000 individual contracts were scrutinized for the period 1947 through 1969.

Once the information in (1)–(3) was obtained, we could then compute for each point in time the number of workers covered by agreements still in effect and the distribution of these workers according to the date of signing. Upon conversion to proportions, these numbers provide estimates of the required weights. These quantities have been constructed for one three-digit industry, (motor vehicles), each two-digit industry (except for ordnance and miscellaneous manufacturing), durable and nondurable manufacturing, and all manufacturing. In each case, the data are quarterly, and cover the period 1949 through 1969.

The numbers just described are counterparts to the weights used in chapter three with the data of Canada. They were also the ones used in the initial stage of this study. However, as noted in the body of the chapter, the results using them were very poor, and one of the problems was thought to be the implicit assumption that in a multi-period contract wages are adjusted at the beginning of every period. In the present context, this would mean that wages are adjusted every quarter. This clearly is not the case, and so the weights underlying the results reported in the text were constructed on the assumption that wages are adjusted at the time of signing and every four quarters thereafter, unless the contract is to expire within two quarters of such an adjustment.

Some comments on the coverage and quality of these weights are in order:

1. In principle, they should reflect every employee working under contract.

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* Work financed by the U.S. National Science Foundation. We are indebted to Janice Benaderet, Mary Freppel, Susie Rust, Paul Sommers, Daniel Weiserbs, and Nicole Weiserbs for research assistance, to Harold Levinson for making available his file of *Current Wage Developments*, to Norman Samuels of the Bureau of Labor Statistics for filling in a few missing early issues, and to Richard Herstein for programming the computations.

In practice this has been impossible to execute, for:

(a) beginning in 1953, BLS did not record contracts covering fewer than 500 workers;

(b) even for agreements covering 500 or more, BLS coverage is incomplete;

(c) some contracts recorded in the wage chronologies could not be used because a vital piece of information was missing and which, in one manner or another, could not be inferred. Omission of the number of employees covered by a contract was the most frequently encountered situation of this type.

2. In Table XXXIV, we have listed the percentage of production workers in manufacturing that is reflected in the contract weights. This is seen to vary from a high of 52 per cent in the third quarter of 1951 to a low of 29.9 per cent in the final quarter of 1967. Since not all of manufacturing is unionized, one could not expect, even in ideal circumstances, that this proportion should approach one. The important consideration is how good an estimate the numbers provide of the proportion of production workers actually under contract, for this is the figure that the numbers should approximate. But, because of "missed" contracts, we cannot expect this to be the case either. If at each point in time the omitted workers should have the same distribution of effective dates of contract as those included and if the ratio of those included to the total under contract were stable through time, the missing contracts would not be a problem. At the level of all manufacturing, these conditions, because of the large numbers involved, probably come fairly close to being satisfied. But, there are a few individual industries—tobacco, textiles, lumber, furniture, apparel and petroleum being the worst—where quarter-to-quarter fluctuations in the proportion of contract workers covered by the estimated are fairly marked.

3. Finally, it should be noted that the estimates constructed here refer to employment at the time contracts were signed and not, as is in principle required by the model, to current employment. However, to base the estimates on current employment would be hopeless even to contemplate.

TABLE XXXIV

Production Workers in Manufacturing

Reflected in Contract Weights

(percentage of total employment)

491	34.2	561	40.9	631	38.9
2	35.1	2	42.2	2	37.9
3	33.8	3	44.0	3	36.9
4	36.3	4	43.8	4	37.8
501	38.5	571	43.5	641	37.7
2	40.5	2	43.5	2	37.0
3	41.8	3	43.1	3	35.5
4	49.9	4	42.5	4	34.2
511	51.4	581	44.5	651	33.0
2	51.1	2	46.0	2	32.8
3	52.0	3	40.5	3	32.8
4	48.4	4	41.3	4	32.7
521	46.8	591	40.5	661	32.3
2	46.4	2	40.2	2	31.5
3	44.0	3	37.6	3	31.0
4	42.2	4	36.6	4	31.0
531	38.9	601	38.7	671	31.6
2	38.9	2	40.2	2	32.0
3	39.6	3	41.1	3	32.0
4	39.3	4	41.5	4	29.9
541	40.5	611	42.2	681	32.3
2	40.2	2	39.6	2	32.2
3	40.3	3	38.6	3	35.4
4	39.0	4	39.5	4	32.6
551	37.7	621	38.3	691	32.1
2	35.1	2	38.5	2	33.0
3	38.0	3	38.4	3	33.1
4	40.4	4	38.6	4	33.1

chapter seven

PRODUCTIVITY AND PRICES IN U. S. MANUFACTURING

In this chapter, we take up the second and third parts of our analysis of U.S. manufacturing, namely, the behavior of labor productivity and of output prices. Since the price models require a measure of unit labor cost corrected for cyclical fluctuations as a predictor, we first present the results for productivity.

A. Productivity

MODELS ANALYZED

The models estimated for productivity—or more accurately, for unit man-hour requirements—are exact counterparts to the linear equations employed in chapter four with Canadian data, and, as has been noted, involve a straightforward application of the methodology of Wilson and Eckstein (1964).[1] The equations in question are as follows:

$$\frac{M_t}{C_t} = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + (\beta_0 + \beta_1 t)\frac{Q_t^p - C_t}{C_t} + (\gamma_0 + \gamma_1 t)\frac{Q_t - Q_t^p}{C_t} + v_t \qquad (1)$$

$$\ln\frac{M_t}{C_t} = \alpha_0 + \alpha_1 t + (\beta_0 + \beta_1 t)\ln\frac{Q_t^p}{C_t} + (\gamma_0 + \gamma_1 t)\ln\frac{Q_t}{Q_t^p} + v_t\,, \qquad (2)$$

[1] One minor difference is that in the Canadian logarithmic equations no time trend in the coefficients β, γ was found to be necessary at the all manufacturing level and therefore was not introduced into the industry equations.

all variables, with the exception of the random disturbance v_t, being defined as in section one of chapter four.

These equations (or abbreviation thereof) have been estimated for:

(1) production worker straight-time hours
(2) production worker overtime hours
(3) total production worker hours
(4) non-production worker hours
(5) total hours of production and non-production workers combined.

Equations have not been estimated for total straight-time hours, as they have for Canada.

DATA

The employment and hours data are those appearing in *Employment and Earnings, United States 1909-1970.*[2] The variables in (1) and (2) are defined as follows:

Manhours

As with the Canadian data [and also following Wilson and Eckstein (1964)], production worker straight-time manhours are based on an assumed standard workweek of 37.5 hours. Hours in excess of 37.5 per week are then recorded as overtime. For non-production workers, a standard workweek of 40 hours is assumed.

Capacity

The figures on capacity have been obtained by dividing the Wharton capacity utilization index into the FRB index of industrial production.[3]

Planned Output

Planned output is defined, as with the Canadian data, as a moving average of output in the three most recent periods with weights in the proportions 3:2:1. It should be noted that this definition of planned output taken in conjunction with the method by which the Wharton utilization index is constructed effectively rules out a planned output in excess of capacity.

Actual Output

Actual output is measured by the FRB index of industrial production. All data are quarterly, seasonally adjusted, and refer to the period 1949:1 through 1969:4.

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[2] U.S. Bureau of Labor Statistics. *Employment and Earnings, United States, 1909–1970.* Washington U.S. Government Printing Office, 1971. (Bulletin No. 1312-7).

[3] We are grateful to the Wharton School of Finance and Commerce, University of Pennsylvania, for making these series available.

All Manufacturing, Durables, and Nondurables

The equations estimated for all manufacturing, durables, and nondurables are tabulated in Table XXXV. The numbers in parentheses in the left-hand column refer to production worker straight-time hours, production worker overtime hours, etc., as listed above. As was the case with the Canadian man-hours equations, autocorrelation in the residuals is pervasive—of all the equations estimated in this section, there is only one (overtime hours for petroleum) for which positive autocorrelation, according to the Durbin-Watson coefficient, appears to be absent—and accordingly the equations have been estimated using the Cochrane-Orcutt transformation.[4] The estimated autoregressive parameter associated with this transformation appears under the column headed by ρ in the table. In addition to the R^2 with the variables measured in original (i.e., untransformed) units, the R^2 in transformed units is also presented, and is denoted by R^2_Δ.

While both versions of the model (i.e., linear and logarithmic) have been estimated, the results with the logarithmic version are inferior to those with the linear version, and accordingly have not been tabulated.

All Manufacturing

The statistical results for all manufacturing are in general very good. Focussing first on the equation for production worker standard hours, we see that all coefficients have the right sign and are several multiples of their standard errors, the fit is excellent (both in levels and after transformation), and autocorrelation is effectively eliminated through use of the Cochrane-Orcutt transformation. In addition, the magnitude of the coefficients relative to one another is as expected *a priori*, for $\hat{\alpha} > \hat{\beta} > \hat{\gamma}$. However, since with exception of the trend terms the variables are all measured as index numbers, the values of the coefficients have little interpretation as they stand, and accordingly are re-expressed as elasticities in Table XXXVI. These will be discussed below.

The equation for production worker overtime hours is also of very good statistical quality, though not of the standards set by production worker straight-time hours. Once, again, we find technological change to be quantitatively important; calculation shows that by the fourth quarter of 1969, $\hat{\beta}$ and $\hat{\gamma}$ have decreased by 82 per cent and 71 per cent, respectively, and $\hat{\alpha}$ by 60 per cent. We also see that the size of the coefficients relative to one another is in reverse order to that for straight-time hours. As noted in chapter three, this is precisely what we should expect since use of overtime serves as a buffer in adjusting output to unanticipated fluctuations in demand.

In the equation for nonproduction worker hours [equation (4)], we find the other extreme, for the short-run adjustment term does not appear at all, and the capacity coefficient $\hat{\alpha}$ is greater than that on planned output. This, too, is in

[4] For a discussion of the Cochrane-Orcutt transformation, see pp. 528–9 of Malinvaud (1970).

line with expectations. The only trend component with statistical importance is the linear term in α. The equation fits well in levels, but in transformed units its performance is well below that of the equations for production workers. Moreover, despite the extremely high value of $\hat{\rho}$ (.977), the Durbin-Watson coefficient remains low, suggesting the structure of autocorrelation may be more complicated than first-order Markov.

The equations for total production worker hours and the total hours of production and non-production workers combined parallel the equation for production worker straight-time hours.

Durable and Nondurable Manufacturing

Turning now to the equations for durable and nondurable manufacturing, we find them to be comparable with those for all manufacturing, not only regarding statistical quality, but in substance as well. In particular:

1. With reference to the equations for production worker straight-time hours, we once again find the pattern of $\hat{\alpha} > \hat{\beta} > \hat{\gamma}$. The principal point of difference between the two subaggregates of manufacturing is in the absence of a trend in β and γ for non-durables.
2. With the overtime equations, there is the pattern, as before, of $\hat{\gamma} > \hat{\beta} > \hat{\alpha}$. The fits of the equations are good, in transformed units as well as levels, and the strong trend away from the use of overtime observed in manufacturing as a whole is seen also to be true of each component. About the only difference in this respect between the two subaggregates is that the trend in α for nondurables is linear and not quadratic as for durables.
3. With non-production worker hours, we find there to be a statistically important, though quantitatively small, reaction to short-run swings in actual output for durables; however, for nondurables, such a reaction is absent altogether. While nondurables has the higher $\overline{R}^2$ in levels, the reverse holds in transformed units, though in neither case is the $\overline{R}^2_\Delta$ particularly high. Finally, it should be noted that in the durables equation substantial autocorrelation remains in the residuals even after the Cochrane-Orcutt transformation.
4. As for all manufacturing, the equations for total production worker hours and the total hours of production and non-production workers combined parallel those for production worker straight-time hours.

Trends and Elasticities

Since the variables are expressed as index numbers and also since the majority of coefficients contain trends, the coefficients in Table XXXV are not readily interpretable. For this reason, Table XXXVI provides a listing of the coefficients, expressed as elasticities, evaluated at three disparate points of the sample period: 1949:1, 1960:1, and 1969:4. As was noted in chapter two, the model allows the calculation of three different types of elasticities, namely:

(1) a short-run elasticity;

(2) an intermediate-run elasticity;

(3) a long-run elasticity, which, on the assumption that actual, planned, and capacity all coincide, we have seen is always equal to unity.

As was the case with the linear equations in chapter four, the assumption that $Q = Q^p = C$ has also been invoked in evaluating the short and intermediate-run elasticities. Besides providing a standard point of reference for the elasticities, this assumption, as we have already noted, also simplifies the calculations, for η_γ and η_β reduce to,

$$\eta_\gamma = \frac{\gamma(t)}{\alpha(t)} \tag{3}$$

$$\eta_\beta = \frac{\beta(t)}{\alpha(t)}. \tag{4}$$

The significant features of the numbers in Table XXXVI can be summarized briefly as follows:

1. Generally speaking, the pattern of elasticities for production worker straight-time hours is seen for the two short-period elasticities to be less than one and for η_γ to be less than η_β. Since straight-time hours are defined on the basis of a standard work week which is assumed to be constant over time, the implication of these results is that production worker employment is sticky in the short run, though less so than for non-production worker employment.
2. In contrast to standard hours, the short-period elasticities for overtime hours are considerably larger than unity, especially those in nondurable manufacturing, and are seen to be larger the shorter the short run. These results are, of course, a corollary to those for standard hours, since with production worker employment becoming progressively more sticky the shorter the period of adjustment, the length of the workweek must necessarily serve as a buffer.
3. In general, for production workers in all manufacturing, technological change since 1960 has acted to reduce the short-run adjustment coefficients relative to unit labor requirements in the long run. The effect of this has been to depress even further η_β and η_γ. However, this phenomenon seems confined to durable manufacturing, for the opposite is seen to hold in nondurable manufacturing.

Trend Improvement in Productivity

Along with the elasticities of Table XXXVI, it is also of interest to calculate the implicit long-run improvement in labor productivity implied by the equations. For the linear model, this is calculated according to the formula,

$$\frac{\dot{y}}{y} = \frac{\alpha_1 + 2\alpha_2 t}{\alpha_0 + \alpha_1 + \alpha_2 t^2} = \frac{\dot{\alpha}(t)}{\alpha(t)}, \tag{5}$$

where $y = M^c/C$ and M^c refers to manhour requirements in the long run. Since

this quantity depends upon t, it is evaluated near the midpoint of the sample period at the first quarter of 1960, which corresponds to $t = 45$. The numbers are tabulated in Table XXXVII.

Of primary interest is the figure for production worker straight-time hours, which we see to be 3.90 per cent per year for all manufacturing, 4.15 per cent for durable manufacturing, and 4.09 per cent for nondurable manufacturing. As is to be expected, the productivity trends for nonproduction workers are not as high.

The Two-digit Industries

The results for the two-digit manufacturing industries are tabulated in Tables XXXVIII – XL. These tables follow the format of Tables XXXV – XXXVII, in that Table XXXVIII contains the estimated equations, Table IXL elasticities, and Table XL the trend improvement in productivity. All two-digit industries have been analyzed with exception of ordnance (19) and miscellaneous manufacturing (39).

Given the number of industries and equations involved, it is clearly unfeasible to discuss each industry individually. Accordingly, in moving through these tables, our comments will necessarily be selective.

Overview

Taken as a whole, the results must be judged to be very satisfactory. For production worker straight-time hours, total production worker hours, and the total hours of production and non-production workers combined, the fits of the equations are excellent. In every case, the $\overline{R}^2$ is above 0.985 in levels and there are only four industries—food, tobacco, printing, and petroleum—which the $\overline{R}^2$ after the Cochrane-Orcutt transformation is below 0.6. T-ratios are typically large, especially for $\hat{\alpha}_0$, $\hat{\beta}_0$, and $\hat{\gamma}_0$, and there are very few instances of wrong signs. As with all manufacturing, durables, and nondurables, autocorrelation is rampant, but with few exceptions has been eliminated, or at least greatly alleviated, through use of the Cochrane-Orcutt transformation.

As with the aggregates, the linear model performs better than the logarithmic one. Only for food (industry 20) does the logarithmic version enjoy a decided advantage over the linear, and this only for production worker straight-time hours.

On the negative side, the following should be noted:

1. The results for industries 20 and 21 (food and tobacco) are clearly the poorest of the entire group. While the $\overline{R}^2$ of the production worker standard hours equation is above 0.99 for both industries, the $\overline{R}_\Delta^2$ is only 0.334 for food and 0.133 for tobacco. The only equations for both industries with $\overline{R}_\Delta^2$ above 0.6 are total production worker hours for food and overtime hours for tobacco. Interestingly enough, the fit after transformation for the latter equation is better than in levels.

2. The equations for non-production worker hours typically leave much to be desired. Rarely is the $\overline{R}_{\Delta}^{2}$ above 0.6, and not infrequently it is below 0.2. The worst equation is for petroleum (industry 29), which includes nothing more than a constant and linear trend as predictors. The equation has an $\overline{R}^{2}$ in levels of 0.989, but its $\overline{R}_{\Delta}^{2}$ is only 0.053.

3. The equations for overtime hours for apparel and leather (industries 23 and 31) both exhibit wrong signs for β_0 and γ_0. For leather, this result, though clearly implausible, is not too upsetting, for it probably reflects the fact that for this industry overtime, as it has been defined, is a rather dubious concept. Leather typically has the shortest average workweek of all the two-digit industries, and over the sample period was frequently short of the 37.5 hours taken as standard. Consequently, little would be lost for this industry if overtime were to be ignored altogether. In the apparel industry, the wrong signs may be a reflection of the frequent use of piecework employment.

Production Worker Straight-Time Manhours

With regard to the results for production worker straight-time hours, the following comments are in order:

1. As already indicated, the statistical quality of the equations, with exception of those for food and tobacco, is very good.

2. With few exceptions, we find (see Table IXL) the expected pattern of $\hat{\alpha} > \hat{\beta} > \hat{\gamma}$. The exceptions are (a) industries 28, 29, 30, 32, and 35 where, because of strong downward trends in $\hat{\alpha}$, $\hat{\alpha}$ at the end of the sample period is less than $\hat{\beta}$, (b) industry 34 where at the end of the period $\hat{\alpha}$ is less than $\hat{\gamma}$, as well as $\hat{\beta}$, and (c) industries 37 and 38 where, again at the end of the period, $\hat{\beta}$ is less than $\hat{\gamma}$. In all other cases, the values of the coefficients relative to one another are as postulated.

3. As to the effects of technological change, there is seen to be rather sharp downward trends in all three coefficients for textiles, apparel, lumber, furniture, leather, primary metals, and transportation equipment, in $\hat{\alpha}$ and $\hat{\beta}$ for rubber, electrical machinery, and instruments, in $\hat{\alpha}$ and $\hat{\gamma}$ for non-electrical machinery, and in $\hat{\alpha}$ alone for food, tobacco, paper, chemicals, petroleum, stone, clay and glass, and fabricated metals. Consequently, we see that in one form or another every industry has experienced a decrease in unit labor requirements. And the fact that every industry displays an α with a downward trend suggests that much of this improvement in labor productivity occurs through investment in new capacity.

Overtime Hours

As was the case with the aggregates, the fit of the equations for overtime hours is not as good as those for straight-time hours. However, because of substantial short-term variability in the average length of workweek, this should not be

surprising. Generally speaking, the $\bar{R}^2$'s are still quite high, and, what is more important, they properly attribute the bulk of the variation in overtime to movements along the shorter of the short-run curves. This is reflected in $\hat{\gamma}$'s which, with exception of lumber, primary metals, and fabricated metals, are all larger than either $\hat{\alpha}$ or $\hat{\beta}$. The strongest trends typically appear in $\hat{\beta}$. This is, of course, what we should expect since it is rational for firms to substitute less costly straight-time hours for overtime hours, and the planning horizon is not so short as to deny firms this flexibility. Indeed, the downward trends in $\hat{\beta}$, are so strong for chemicals, petroleum, electrical machinery, and instruments that its value at the end of the sample period is actually negative. In these cases, a nonlinear trend would probably be more appropriate.

As already noted, the overtime equations for apparel and leather are clearly implausible and should be ignored.

Non-production Worker Hours

The overwhelming feature of the equations for non-production workers is the absence of any adjustment of their hours to short-run changes in actual output, for apparel and electrical machinery are the only industries for which actual output appears as a predictor. As was indicated earlier, this reflects the essential overhead character of non-production workers, and is, of course, precisely what we expect *a priori.*

It is also interesting to note the absence of any strong impact of technological change. Although trends appear in $\hat{\alpha}$ for all industries except primary metals and non-electrical machinery, these trends are, with the odd exception, fairly shallow, and in addition do not display any particular pattern. While the majority are decreasing, as with production worker straight-time hours, several are increasing, and three are nonmonotonic. For paper and leather, $\hat{\alpha}$ first falls and then rises, while for stone, clay, and glass, we find the opposite.

It was remarked earlier that this particular set of equations is the least satisfactory statistically of the several groups estimated. Wilson and Eckstein also encountered this in their study and attributed the problem to an inappropriate measure of planned output. They reasoned that because of the strong overhead character of non-production personnel, planned output for this category of labor input should be defined over a longer horizon than three quarters. As a substitute, they defined planned output as a geometric distributed lag on past output. Since this measure led to improved results, it perhaps ought to have been considered here as well. However, since this problem did not arise with the Canadian equations, we decided to leave the results as they stand.

Total Production and Non-production Worker Hours Combined

In general, the equations for total production worker hours and total hours of production and non-production workers combined parallel those for production worker straight-time hours. They are of the same quality statistically, and the

pattern of coefficients is on the whole what we expect, though with these equations we can only speak of a general tendency for $\hat{\alpha}$ to be greater than $\hat{\beta}$ and for $\hat{\beta}$ to be greater than $\hat{\gamma}$. For with overtime in the picture, there is now no reason to expect $\hat{\beta}$ invariably to exceed $\hat{\gamma}$; indeed, there are a number of instances where, because of a strong trend in $\hat{\beta}$, the reverse is seen to hold.

Trends and Elasticities

As for aggregates, the coefficients in Table XXXVIII have been expressed as elasticities on the assumption $Q = Q^* = C$ and evaluated at the first quarter of 1949, the first quarter of 1960, and the fourth quarter of 1969, corresponding to $t = 1$, 45, and 84, respectively. We have already noted the general pattern of coefficients relative to one another, and since this necessarily carries over to the elasticities, that ground has already been covered. Suffice it here to note that, generally speaking, the short-run production worker straight-time elasticities are less than one and are smaller the shorter the period of adjustment, while the short-run overtime elasticities are greater than one, and indeed are frequently in excess of two. Because of this, the short-run elasticities for total production worker hours are typically greater than their counterparts for standard hours, and because of the small elasticity for non-production workers, there is more short-run inertia in the total of production and non-production worker hours combined than in production worker hours taken by themselves.

As with the aggregates, it is once again not unusual to find, except for those cases where trends are absent from $\hat{\beta}$ or $\hat{\gamma}$, for the short-period elasticities to be quite stable between 1949:1, and 1960:1 and then to drop fairly sharply between 1960:1 and 1969:4. However, before making too much of this, it is well to reflect on the mathematical mechanism through which this is brought about. Mechanically, this arises through the interaction of the quadratic trend in α and a linear trend in β or γ. That the decrease in α typically slows between 1960:1 and 1969:4 relative to the trend in β and γ may reflect nothing more than the requirement that with $\alpha_0 < 0$ and $\alpha_1 > 0$, $\alpha(t)$ must eventually turn up. While this may in fact be the way that the trend is behaving at the end of the period—and that the quadratic term is typically multiples of its standard error is certainly evidence that this is the case—but in an empirical exercise of this type one unfortunately can never be sure. Thus, the typically sharp drop in η_β and η_γ at the end of the period may simply be a reflection of a defect in the analytical form of trends used. In view of this, one should perhaps place the most reliance on the values of the elasticities calculated at 1960:1, this because this date being near the midpoint of the sample period the elasticity will approximate a mean value.

In addition to the problems already catalogued for the overtime equations for apparel and leather, several new ones have arisen in the form of negative values for $\hat{\beta}$ at the end of the period in the (overtime) equations for chemicals, petroleum, electrical machinery, and instruments. There is one other case of $\hat{\beta}$ being negative at the end of the period, this being in the equation for nonproduction workers. The problem in these cases is with the linear trend; it lacks the good sense to have $\hat{\beta}$ remain at zero once that value is reached.

One final item worthy of note is that, in general, the "heavy" industries, namely, industries 33-38, display the least amount of stickiness in the adjustment of their work forces to short-run variation in demand. This is probably a reflection of the fact that demand for the output of these industries has traditionally been cyclically volatile, and firms have accordingly learned to adjust their output and employment on short notice.

Trend Improvements in Productivity

The trend improvement factors in productivity, once again calculated at t corresponding to the first quarter of 1960, are tabulated in Table XL. As the eye moves down the column headed by (1), corresponding to production worker straight-time hours, several items stand out:

(1) those industries with particularly good long-term trends in productivity are chemicals, petroleum, transportation equipment, and instruments;

(2) those with about average performance are tobacco, lumber, food, and rubber;

(3) finally those industries with fairly poor performances are food, paper, printing, leather, stone, clay and glass, primary metals, fabricated metals, and non-electrical machinery.

CONCLUSIONS

The impressive performance of the Wilson-Eckstein model for all manufacturing, based originally on data through 1960, is not diluted by the addition of 36 more quarters of data. However, given the nature of aggregate time-series data, this is hardly surprising. Much more impressive is the fact that the model performs well, though not quite uniformly so, when all manufacturing is disaggregated, first to durables and nondurables, and then to 19 two-digit industries.

The long-term increase in production worker productivity (straight-time hours) in all manufacturing calculated at the midpoint of the sample period is indicated to have been at a rate of about 3.9 per cent per year. Two-digit industries with particularly good productivity performances were chemicals, petroleum, transportation equipment, and instruments, while those whose productivity was performing very poorly were food, paper, leather, stone, clay and glass, primary metals, fabricated metals, and non-electrical machinery.

However, we should not leave the impression that this straight-forward application of the Wilson-Eckstein model has led to unequivocably plausible results. The equations for non-production workers, especially as regards their fit after transformation to eliminate autocorrelation, are in general not up to the standards of the equations for production worker straight-time hours. Wilson and Eckstein actually anticipated this problem, and found that for this category of labor input it is preferable to define planned output as a geometric distributed lag on past output.

Anomalies are also present in the overtime equations for a number of industries. For some industries, because of the shortness of the work week in relation to the number of hours taken as standard, the concept of overtime that we have used probably has little basis in fact. In future work, one might be better advised (1) to employ a shorter standard workweek for the industries involved, or (2) to take as the quantity to be explained the average length of the workweek rather than the amount of overtime.

Taken as a whole, however, these equations provide an adequate foundation for the estimates of normal and corrected unit labor costs to be used in the price equations. We now turn to a discussion of these equations.

TABLE XXXV

Manhour Equation

U.S. Manufacturing

	α_0	α_1	α_2	β_0	β_1	γ_0	γ_1	$\bar{R}^2$	S.E.	D.W.	ρ	R^2_Δ
All Manufacturing												
(1)	148.85	−1.466	0.00599	1.297	−0.00986	0.831	−0.00682	0.999	0.54	1.81	0.865	0.942
	(63.22)	(−13.46)	(6.01)	(20.84)	(−5.23)	(16.74)	(−5.00)					
(2)	245.18	−3.299	0.0180	6.310	−0.0734	6.847	−0.0582	0.966	6.42	2.06	0.736	0.817
	(14.49)	(−4.08)	(2.52)	(8.68)	(−3.55)	(11.42)	(−3.55)					
(3)	153.98	−1.536	0.00638	1.558	−0.0123	1.177	−0.00973	0.999	0.64	1.89	0.776	0.948
	(82.29)	(−17.07)	(7.89)	(21.13)	(−5.73)	(19.59)	(−5.92)					
(4)	97.06	−0.297		0.248				0.989	0.51	0.91	0.977	0.465
	(10.90)	(−2.95)		(8.20)								
(5)	136.82	−1.185	0.00457	1.231	−0.00989	0.879	−0.00710	0.999	0.53	1.83	0.895	0.942
	(45.43)	(−8.98)	(3.83)	(20.42)	(−5.36)	(18.35)	(−5.40)					
Durables												
(1)	146.11	−1.359	0.00559	1.243	−0.00825	0.902	−0.00789	0.999	0.76	1.68	0.752	0.942
	(72.85)	(14.09)	(6.42)	(19.22)	(−4.42)	(18.72)	(−5.92)					
(2)	250.90	−3.609	0.0224	4.752	−0.0521	5.186	−0.0467	0.967	6.73	1.91	0.815	0.823
	(11.43)	(−3.44)	(2.32)	(8.18)	(−3.01)	(12.18)	(−3.97)					
(3)	152.81	−1.489	0.00653	1.492	−0.0113	1.199	−0.0105	0.998	0.88	1.62	0.725	0.948
	(69.91)	(−14.24)	(6.97)	(20.09)	(−5.33)	(21.48)	(−6.83)					
(4)	64.86	0.508	−0.00533	0.263		0.0692		0.957	0.63	0.59	0.917	0.521
	(15.79)	(3.07)	(−3.50)	(8.68)		(3.39)						
(5)	130.58	−1.000	0.00367	1.157	−0.00836	0.883	−0.00749	0.998	0.70	1.56	0.811	0.943
	(58.33)	(−9.32)	(3.73)	(19.09)	(−4.64)	(19.88)	(−6.10)					
Nondurables												
(1)	151.11	−1.535	0.00628	0.927		0.525		0.999	0.40	1.63	0.883	0.879
	(86.88)	(−20.25)	(8.49)	(20.37)		(15.44)						
(2)	221.04	−1.555		9.477	−0.0662	12.229	−0.0779	0.943	7.97	2.07	0.558	0.771
	(19.77)	(−7.57)		(8.05)	(−2.59)	(10.47)	(−2.43)					
(3)	153.09	−1.494	0.00576	1.208		0.930		0.999	0.64	1.70	0.776	0.860
	(121.53)	(−25.54)	(9.18)	(17.46)		(16.92)						
(4)	127.95	−1.041	0.00420	0.223				0.998	0.39	1.75	0.960	0.361
	(13.03)	(−3.71)	(2.03)	(5.65)								
(5)	141.22	−1.242	0.00445	0.968		0.705		0.999	0.51	1.77	0.866	0.850
	(77.40)	(−15.21)	(5.45)	(16.75)		(16.19)						

TABLE XXXVI

Manhours Elasticities
U.S. Manufacturing

	All Manufacturing		Durables		Nondurables	
	η_β	η_γ	η_β	η_γ	η_β	η_γ
production worker straight-time hours						
491	0.873	0.559	0.853	0.618	0.620	0.351
601	0.897	0.551	0.906	0.568	0.978	0.554
694	0.690	0.380	0.770	0.335	1.394	0.790
overtime hours						
491	2.578	2.807	1.900	2.078	4.287	5.536
601	2.258	3.175	1.799	2.305	4.301	5.775
694	1.203	2.060	0.355	1.595	4.332	6.289
total production worker hours						
491	1.014	0.765	0.960	0.771	0.797	0.613
601	1.028	0.756	0.994	0.734	1.239	0.954
694	0.750	0.515	0.736	0.429	1.770	1.363
non-production worker hours						
491	0.256		0.402	0.106	0.176	
601	0.296		0.342	0.090	0.249	
694	0.343		0.376	0.099	0.318	
total hours						
491	0.900	0.643	0.887	0.676	0.692	0.504
601	0.847	0.604	0.840	0.587	1.026	0.747
694	0.575	0.407	0.628	0.350	1.417	1.032

NOTE: See text for definitions of η_β and η_γ.

TABLE XXXVII

Long-Term Rate of Growth of Productivity
U.S. Manufacturing
(Annual rates in per cent, calculated at 1960:1)

	(1)	(2)	(3)	(4)	(5)
All Manufacturing	3.90	5.04	3.93	1.42	3.33
Durable Manufacturing	4.15	4.76	3.64	−0.15	3.69
Nondurable Manufacturing	4.09	4.12	4.00	2.96	3.57

NOTE: (1) production worker straight-time hours
(2) overtime hours
(3) total production worker hours
(4) non-production worker hours
(5) total production and non-production worker hours

TABLE XXXVIII

Manhour Equations

U.S. 2-Digit Manufacturing

	α_0	α_1	α_2	β_0	β_1	γ_0	γ_1	$\bar{R}^2$	S.E.	D.W.	ρ	R^2_Δ
20 *Food*												
(1)	4.853	−0.00722		0.455		0.409		0.999	0.0064	2.03	0.974	0.334
	(57.91)	(−6.99)		(5.82)		(5.95)						
(2)	226.20	−3.341	0.0174	4.525	−0.0456	2.130		0.983	4.28	2.26	0.717	0.321
	(13.79)	(−6.59)	(4.12)	(3.40)	(−1.91)	(4.01)						
(3)	144.29	−1.410	0.00640	0.606		0.548		0.999	0.69	2.17	0.848	0.691
	(63.67)	(−14.96)	(6.67)	(6.37)		(6.54)						
(4)	87.55	0.146	−0.00412	0.0598				0.991	0.51	2.14	0.819	0.297
	(68.55)	(2.47)	(−6.79)	(2.07)								
(5)	126.55	−0.930	0.00318	0.438		0.380		0.999	0.49	2.14	0.867	0.437
	(67.21)	(−11.87)	(4.08)	(6.56)		(6.46)						
21 *Tobacco*												
(1)	142.05	−1.020						0.994	2.01	2.15	0.754	0.133
	(73.20)	(−27.28)										
(2)		3.420	−0.0406			17.411	−0.144	0.641	28.37	1.98	0.273	0.694
		(9.60)	−(7.55)			(6.22)	(−2.70)					
(3)	140.08	−1.008		0.346				0.990	2.48	2.04	0.597	0.332
	(90.38)	(−35.86)		(3.38)								
(4)	83.86	0.0893		0.578				0.547	4.58	2.09	0.707	0.178
	(21.30)	(1.19)		(1.83)								
(5)	132.55	−0.873		0.287				0.991	2.06	1.97	0.506	0.366
	(137.63)	(−45.64)										
22 *Textiles*												
(1)	169.08	−2.108	0.0110	1.291	−0.0115	0.736	−0.00848	0.999	0.80	1.85	0.825	0.921
	(74.29)	(−19.10)	(10.08)	(17.68)	(−5.42)	(16.11)	(−6.48)					

(2)	165.35	−0.660		9.865	−0.123	11.595	−0.115	0.906	14.01	1.84	0.367	0.819
	(16.78)	(−3.78)		(10.76)	(−6.25)	(14.60)	(−5.21)					
(3)	165.53	−1.875	0.00905	1.678	−0.0148	1.314	−0.0140	0.998	1.13	1.77	0.638	0.927
	(94.75)	(−20.90)	(10.26)	(17.33)	(−5.52)	(19.76)	(−7.48)					
(4)	117.18	−0.950	0.00683	0.392				0.977	1.21	2.32	0.873	0.492
	(25.94)	(−4.69)	(3.41)	(7.72)								
(5)	160.18	−1.759	0.00861	1.537	−0.0129	1.188	−0.0126	0.998	1.04	1.81	0.691	0.926
	(89.10)	(−19.09)	(9.46)	(16.75)	(−5.01)	(19.41)	(−7.25)					
23	*Apparel*											
(1)	134.76	−1.170	0.00487	0.888	−0.00652	0.445	−0.00351	0.999	0.64	2.11	0.866	0.748
	(57.83)	(−11.30)	(4.46)	(9.09)	(−2.72)	(7.31)	(−2.27)					
(2)	48.50			−6.770	0.0804	−4.544		0.734	12.57	2.18	0.566	0.509
	(7.50)			(−6.88)	(5.70)	(−7.10)						
(3)	139.12	−1.200	0.00471	1.423	−0.0134	0.795	−0.00561	0.995	1.24	2.16	0.802	0.684
	(47.37)	(−9.11)	(3.21)	(7.68)	(−3.10)	(6.68)	(−1.88)					
(4)	117.67	−0.567		0.553	−0.00760	0.336	−0.00620	0.996	0.85	1.57	0.945	0.312
	(26.04)	(−7.27)		(4.36)	(−2.40)	(4.35)	(−3.16)					
(5)	137.70	−1.183	0.00473	1.315	−0.0126	0.735	−0.00559	0.995	1.13	2.15	0.828	0.684
	(44.42)	(−8.48)	(3.10)	(7.74)	(−3.11)	(6.83)	(−2.06)					
24	*Lumber*											
(1)	162.26	−1.775	0.00935	1.375	−0.0125	0.892	−0.00955	0.996	1.37	1.94	0.779	0.810
	(56.29)	(−13.11)	(6.90)	(12.13)	(−4.31)	(11.92)	(−5.71)					
(2)	159.47	−1.606	0.0203	3.454		3.325		0.771	16.71	2.27	0.635	0.445
	(8.58)	(−1.77)	(2.07)	(4.66)		(6.69)						
(3)	161.59	−1.734	0.00943	1.530	−0.0132	1.067		0.996	1.46	1.89	0.811	0.838
	(44.69)	(−10.31)	(5.61)	(12.66)	(−4.31)	(13.59)						
(4)	118.63	−1.110	0.0101	0.153				0.949	1.41	1.72	0.904	0.141
	(15.50)	(−3.48)	(3.37)	(2.55)								
(5)	156.03	−1.638	0.00934	1.377	−0.0116	0.937	−0.00911	0.996	1.33	1.85	0.824	0.831
	(43.44)	(−9.87)	(5.64)	(12.38)	(−4.09)	(13.06)	(−5.67)					

Table XXXVIII (*Continued*)

	α_0	α_1	α_2	β_0	β_1	γ_0	γ_1	$\bar{R}^2$	S.E.	D.W.	ρ	R^2_Δ
25 *Furniture*												
(1)	157.82	−1.920	0.0100	1.279	−0.0119	0.820	−0.00719	0.998	0.96	0.88	0.906	0.840
	(26.96)	(−8.06)	(4.55)	(13.80)	(−4.57)	(10.51)	(−3.55)					
(2)	319.04	−6.318	0.0463	5.704	−0.0340	6.091		0.957	9.50	1.93	0.823	0.771
	(11.66)	(−5.26)	(3.96)	(6.86)	(−1.49)	(14.06)						
(3)	165.92	−2.124	0.0116	1.593	−0.0147	1.220	−0.00937	0.997	1.21	1.01	0.883	0.861
	(29.31)	(−8.84)	(5.06)	(13.54)	(−4.46)	(12.25)	(−3.63)					
(4)	109.13	−0.527		0.232				0.989	1.06	2.29	0.917	0.287
	(31.78)	(−9.25)		(4.34)								
(5)	156.74	−1.865	0.00966	1.391	−0.0127	1.045	−0.00803	0.997	1.05	1.03	0.892	0.862
	(29.01)	(−8.25)	(4.54)	(13.71)	(−4.48)	(12.20)	(−3.61)					
26 *Paper*												
(1)	118.58	−0.641		0.611		0.306		0.999	0.56	1.47	0.880	0.771
	(89.27)	(−29.10)		(15.30)		(10.88)						
(2)	159.31	−1.672	0.00777	2.837	−0.0218	3.148	−0.0219	0.970	3.38	2.20	0.757	0.806
	(19.22)	(−4.06)	(1.99)	(8.01)	(−1.89)	(11.83)	(−2.35)					
(3)	122.50	−0.679		0.820		0.589		0.998	0.71	1.74	0.843	0.831
	(93.10)	(−31.77)		(16.33)		(16.32)						
(4)	69.63	0.561	−0.00618	0.164				0.972	0.63	1.63	0.917	0.256
	(16.77)	(3.37)	(−4.04)	(4.16)								
(5)	114.51	−0.557		0.690		0.473		0.998	0.60	1.62	0.857	0.823
	(95.49)	(−28.31)		(16.15)		(15.51)						
27 *Printing*												
(1)	109.02	−0.432		0.469		0.273		0.990	0.36	1.43	0.943	0.578
	(59.84)	(−15.37)		(8.82)		(8.29)						

(2)	219.33	−1.520		4.982		5.042		0.890	17.30	1.84	0.806	0.193
	(9.34)	(−3.80)		(2.15)		(3.12)						
(3)	112.05	−0.466		0.571		0.361		0.998	0.49	1.36	0.880	0.555
	(103.40)	(−25.33)		(8.18)		(8.05)						
(4)	102.55	−0.293		0.120				0.995	0.54	1.87	0.943	0.057
	(37.22)	(−6.90)		(1.72)								
(5)	108.08	−0.392		0.445		0.286		0.999	0.37	1.46	0.949	0.573
	(53.27)	(−12.78)		(8.35)		(8.67)						
28	*Chemicals*											
(1)	186.10	−2.576	0.0120	0.944				0.990	1.27	1.10	0.706	0.666
	(106.53)	(−29.06)	(12.55)	(13.59)								
(2)	181.84	−3.036	0.0176	2.310	−0.0337	1.752		0.989	3.52	1.96	0.489	0.606
	(38.09)	(−12.91)	(8.45)	(8.63)	(−4.70)	(8.11)						
(3)	186.65	−2.658	0.0126	1.346	−0.00762			0.999	1.00	1.41	0.703	0.824
	(90.14)	(−24.86)	(12.87)	(14.07)	(−2.80)							
(4)	115.94	−0.704		0.458				0.997	0.90	0.77	0.971	0.416
	(10.92)	(−5.21)		(7.50)								
(5)	155.56	−1.727	0.00625	0.803				0.999	1.09	1.19	0.807	0.611
	(65.22)	(−14.74)	(5.13)	(11.79)								
29	*Petroleum*											
(1)	190.74	−2.479	0.0111	1.064		0.606		0.997	2.19	2.11	0.688	0.424
	(43.98)	(−16.72)	(7.03)	(4.89)		(5.44)						
(2)	171.14	−2.310	0.0139	3.371	−0.0603	3.502	−0.0371	0.906	6.97	1.75		
	(32.64)	(−10.88)	(7.85)	(6.09)	(−3.09)	(6.69)	(−2.30)					
(3)	188.01	−2.407	0.0109	1.210		0.847		0.996	2.29	2.07	0.648	0.534
	(57.11)	(−17.44)	(1.43)	(5.46)		(7.24)						
(4)	136.79	−0.807						0.989	1.49	1.93	0.966	0.053
	(8.94)	(−3.98)										
(5)	157.59	−1.470	0.00406	0.891		0.632		0.996	1.81	2.25	0.822	0.451
	(32.80)	(−6.88)	(1.87)	(4.71)		(7.05)						

TABLE XXXVIII *(Continued)*

	α_0	α_1	α_2	β_0	β_1	γ_0	γ_1	$\bar{R}^2$	S.E.	D.W.	ρ	R^2_Δ
30	*Rubber*											
(1)	141.17	−1.302	0.00491	1.064	−0.00405	0.477		0.966	1.31	1.97	0.780	0.826
	(46.96)	(−9.17)	(3.48)	(12.02)	(−1.96)	(13.77)						
(2)	185.43	−1.130		5.506	−0.0487	6.162	−0.0599	0.892	11.41	2.15	0.633	0.758
	(15.44)	(−5.22)		(7.29)	(−2.91)	(10.37)	(−4.42)					
(3)	146.66	−1.411	0.00572	1.411	−0.00887	0.936	−0.00608	0.996	1.31	1.90	0.828	0.897
	(38.29)	(14.06)	(3.25)	(14.06)	(−3.50)	(13.93)	(−3.85)					
(4)	100.63	−0.448		0.192				0.989	1.25	2.07	0.907	0.213
	(28.29)	(−7.44)		(4.24)								
(5)	132.48	−0.999	0.00275	0.931		0.579		0.995	1.21	1.70	0.841	0.862
	(38.06)	(−6.17)	(1.67)	(17.75)		(18.72)						
31	*Leather*											
(1)	127.61	−0.752	0.00281	0.959	−0.00583	0.667	−0.00623	0.996	0.063	2.36	0.744	0.861
	(94.95)	(13.95)	(5.19)	(13.36)	(−3.94)	(13.43)	(−6.75)					
(2)	−987.65	24.876	−0.292	−70.454		−89.909		0.810	20.25	2.28	0.644	0.667
	(−3.45)	(2.11)	(−2.232)	(−5.70)		(−10.89)						
(3)	133.86	−0.901	0.00417	1.372	−0.00845	1.206	−0.0101	0.989	1.08	2.38	0.783	0.853
	(51.85)	(−8.42)	(3.85)	(11.23)	(−3.27)	(14.24)	(−6.42)					
(4)	101.76	−0.424	0.00489	0.0973				0.854	1.38	2.10	0.828	0.126
	(26.68)	(−2.49)	(2.81)	(1.25)								
(5)	129.76	−0.838	0.00424	1.206	−0.00714	1.060	−0.00888	0.990	0.93	2.28	0.774	0.857
	(59.58)	(−9.34)	(4.69)	(11.41)	(−3.20)	(14.44)	(−6.51)					
32	*Stone, Clay, and Glass*											
(1)	128.81	−0.805	0.00153	0.797		0.547		0.998	0.77	1.73	0.572	0.871
	(168.56)	(−22.43)	(3.76)	(21.58)		(15.76)						

(2)	169.88	−0.800		4.401	−0.0247	3.885		0.929	6.11	2.09	0.576	0.751
	(26.64)	(−7.01)		(9.96)	(−2.47)	(14.27)						
(3)	133.00	−0.870	0.00198	1.106	−0.00364	0.802		0.997	0.91	1.65	0.462	0.892
	(116.88)	(−15.83)	(3.87)	(17.83)	(−2.16)	(20.16)						
(4)	75.17	0.373	−0.00467	0.179				0.906	0.72	1.77	0.710	0.406
	(71.27)	(7.52)	(−8.64)	(4.90)								
(5)	121.85	−0.632	0.000746	0.903	−0.00240	0.640		0.997	0.75	1.66	0.441	0.894
	(134.29)	(−14.47)	(1.84)	(18.11)	(−1.78)	(19.80)						
33	*Primary Metals*											
(1)	126.58	−0.854	0.00322	1.017	−0.00815	0.898	−0.00959	0.987	1.76	1.86	0.705	0.931
	(44.81)	(−5.94)	(2.23)	(12.17)	(−3.70)	(20.21)	(−8.58)					
(2)	193.19			4.062		4.019	−0.0223	0.919	18.45	1.74	0.782	0.774
	(17.20)			(9.10)		(9.93)	(−2.39)					
(3)	132.34	−0.910	0.00383	1.267	−0.0101	1.088	−0.0110	0.992	1.48	1.92	0.658	0.966
	(63.88)	(−8.56)	(3.61)	(18.26)	(−5.57)	(28.83)	(−11.60)					
(4)	76.54			0.0825				0.878	1.18	1.34	0.930	0.169
	(40.99)			(3.65)								
(5)	121.86	−0.765	0.00339	1.054	−0.00882	0.889	−0.00912	0.990	1.30	1.95	0.774	0.961
	(45.08)	(−5.69)	(2.52)	(16.87)	(−5.28)	(27.50)	(−11.16)					
34	*Fabricated Metals*											
(1)	124.65	−0.585		0.985		0.806	−0.00406	0.994	1.06	1.74	0.909	0.870
	(39.13)	(−10.91)		(18.26)		(13.18)	(−2.55)					
(2)	170.60	−0.722		3.132		4.600	−0.0291	0.929	7.66	2.04	0.808	0.761
	(15.85)	(−3.89)		(8.16)		(10.15)	(−2.45)					
(3)	127.82	−0.592		1.149	−0.00598			0.992	1.29	1.79	0.841	0.880
	(59.50)	(−15.88)		(17.64)	(−3.02)							
(4)	178.37	−0.894		0.252				0.989	0.79	0.87	0.987	0.441
	(5.35)	(−3.25)		(7.47)								
(5)	121.16	−0.534		0.932		0.825	−0.00407	0.992	1.06	1.72	0.927	0.870
	(30.89)	(−8.31)		(17.40)		(13.63)	(−2.59)					

TABLE XXXVIII *(Concluded)*

	α_0	α_1	α_2	β_0	β_1	γ_0	γ_1	$\bar{R}^2$	S.E.	D.W.	ρ	R^2_Δ
35	*Non-electrical Machinery*											
(1)	124.24	−0.560		0.945		0.898	−0.00771	0.997	1.04	1.34	0.815	0.882
	(81.24)	(−23.06)		(24.42)		(11.74)	(−3.79)					
(2)	221.09	−2.682	0.0162	4.290	−0.0418	5.827	−0.0501	0.975	6.59	1.77	0.756	0.801
	(14.25)	(−3.48)	(2.25)	(9.77)	(−3.34)	(11.84)	(−3.69)					
(3)	131.59	−0.684		1.307	−0.00587	1.350	−0.0126	0.996	1.19	1.58	0.756	0.903
	(85.93)	(−21.60)		(17.97)	−(3.19)	(15.21)	−(5.18)					
(4)	70.68			0.391	−0.00182			0.986	0.67	0.76	0.989	0.682
	(12.65)			(8.85)	(−1.414)							
(5)	116.48	−0.512		0.990	−0.00348	0.681		0.995	1.03	1.44	0.900	0.872
	(41.62)	(−10.10)		(14.49)	(−1.84)	(15.55)						
36	*Electrical Machinery*											
(1)	133.94	−1.286	0.00598	1.207	−0.00850	0.455		0.994	1.29	1.21	0.881	0.832
	(21.82)	(−4.54)	(2.24)	(14.80)	(−3.40)	(11.01)						
(2)	224.63	−3.869	0.0247	3.729	−0.0496	2.382		0.938	8.28	2.09	0.761	0.621
	(11.40)	(−3.77)	(2.52)	(7.24)	(−3.31)	(8.87)						
(3)	141.71	−1.528	0.00784	1.363	−0.0111	0.580		0.992	1.55	1.46	0.873	0.816
	(21.23)	(−4.85)	(2.63)	(13.96)	(−3.71)	(11.70)						
(4)	51.18	0.368	−0.00272			−0.0645		0.904	0.87	0.57	0.893	0.269
	(4.25)	(2.03)	(−1.57)			(−2.57)						
(5)	110.87	−0.809	0.00349	0.913	−0.00597	0.378		0.991	1.12	1.24	0.885	0.801
		(−3.25)	(1.49)	(13.00)	(−2.77)	(10.63)						
37	*Transportation Equipment*											
(1)	223.11	−3.471	0.0204	1.910	−0.0192	1.218	−0.0106	0.995	2.05	1.84	0.903	0.865
	(16.82)	(−6.46)	(4.25)	(12.11)	(−4.52)	(13.84)	(−5.05)					

(2)	217.67	−1.304		1.808		4.673		0.887	15.96	2.15	0.753	0.707
	(8.97)	(−4.04)		(2.97)		(12.33)						
(3)	201.37	−2.479	0.0136	1.330		1.503	−0.0110	0.993	2.60	1.67	0.882	0.851
	(18.24)	(−5.31)	(2.99)	(12.59)		(13.78)	(−4.29)					
(4)	98.11	−0.344		0.260				0.968	1.56	0.93	0.963	0.216
	(7.30)	(−1.86)		(4.51)								
(5)	169.72	−1.840	0.00965	1.013		1.061	−0.00727	0.992	2.00	1.43	0.924	0.836
	(10.24)	(−2.92)	(1.72)	(12.45)		(12.87)	(−3.76)					
38	*Instruments*											
(1)	175.60	−2.488	0.0138	1.511	−0.0162	0.392		0.999	0.89	1.15	0.827	0.855
	(59.75)	(−19.35)	(11.46)	(19.49)	(−7.89)	(7.61)						
(2)	300.44	−6.833	0.0487	5.153	−0.0745	4.425	−0.0353	0.957	8.72	1.45	0.870	0.578
	(8.04)	(−4.25)	(3.25)	(6.20)	(−3.38)	(4.89)	(−1.53)					
(3)	184.89	−2.819	0.0165	1.755	−0.0199	0.616		0.998	1.28	1.05	0.836	0.800
	(41.50)	(−14.50)	(9.06)	(15.59)	(−6.67)	(8.28)						
(4)	95.55	−0.276		0.374				0.985	0.73	1.65	0.952	0.556
	(22.06)	(−4.24)		(9.66)								
(5)	149.26	−1.791	0.00965	1.279	−0.0127	0.410		0.998	0.90	1.01	0.849	0.815

Table IXL

Manhours Elasticities

U.S. 2-Digit Manufacturing Industries

	Food		Tobacco		Textiles		Apparel		Lumber	
	η_β	η_γ	η_β	η_γ	η_β	η_γ	η_β	η_γ	η_β	η_γ
production worker straight-time hours										
491	0.455	0.409			0.767	0.436	0.659	0.330	0.849	0.550
601	0.455	0.409			0.802	0.367	0.647	0.312	0.802	0.456
694	0.455	0.409			0.467	0.034	0.480	0.211	0.411	0.114
overtime hours										
491	2.010	0.956							2.245	2.106
601	2.226	1.917	[not calculated]			[not calculated]			2.692	2.592
694	1.017	3.117							2.058	1.982
total production worker hours										
491	0.424	0.384	0.249		1.016	0.794	1.022	0.572	0.949	0.667
601	0.646	0.584	0.365		1.017	0.651	0.866	0.574	0.912	1.039
694	0.854	0.772	0.624		0.605	0.192	0.415	0.452	0.510	1.294
non-production worker hours										
491	0.068		0.689		0.337		0.465	0.282	0.130	
601	0.070		0.658		0.444		0.229	0.062	0.172	
694	0.085		0.633		0.458		−0.911	−0.744	0.215	
total hours										
491	0.348	0.302	0.218		0.962	0.742	0.954	0.534	0.884	0.601
601	0.480	0.416	0.308		0.972	0.631	0.799	0.516	0.845	0.521
694	0.617	0.535	0.485		0.619	0.178	0.358	0.400	0.478	0.204
	Furniture		**Paper**		**Printing**		**Chemicals**		**Petroleum**	
	η_β	η_γ	η_β	η_γ	η_β	η_γ	η_β	η_γ	η_β	η_γ
production worker straight-time hours										
491	0.813	0.521	0.518	0.259	0.432	0.251	0.514		0.565	0.322
601	0.812	0.541	0.681	0.341	0.524	0.305	0.999		1.047	0.596
694	0.416	0.322	0.944	0.473	0.645	0.375	1.736		1.749	0.996
overtime hours										
491	1.803	1.947	1.786	1.983	2.287	2.315	1.275	0.980	1.961	2.052
601	3.249	4.740	1.869	2.167	3.301	3.341	0.982	2.175	0.690	1.923
694	2.476	5.296	1.365	1.775	5.436	5.501	−1.022	3.435	−2.253	0.513
total production worker hours										
491	0.963	0.739	0.673	0.484	0.512	0.324	0.727		0.652	0.456
601	0.993	0.850	0.892	0.641	0.627	0.396	1.084		1.189	0.832
694	0.516	0.624	1.253	0.900	0.783	0.498	1.350		1.929	1.350
non-production worker hours										
491	0.200		0.234		0.117		0.393			
601	0.325		0.234		0.134		0.544			
694	0.329		0.234		0.154		0.806			
total hours										
491	0.890	0.670	0.606	0.606	0.413	0.266	0.522		0.405	0.405
601	0.880	0.740	0.771	0.771	0.492	0.316	0.881		0.634	0.634
694	0.470	0.542	1.019	1.019	0.592	0.381	1.471		1.007	1.007

Note: See text for definitions of η_β and η_γ.

TABLE IXL *(Concluded)*

	Rubber		Leather		Stone, Clay and Glass		Primary Metals		Fabricated Metals	
	η_β	η_γ	η_β	η_γ	η_β	η_γ	η_β	η_γ	η_β	η_γ
production worker straight-time hours										
491	0.758	0.341	0.751	0.521	0.623	0.427	0.803	0.706	0.794	0.650
601	0.953	0.516	0.701	0.389	0.833	0.572	0.687	0.492	1.002	0.820
694	1.090	0.718	0.557	0.171	1.107	0.760	0.428	0.119	1.304	1.067
overtime hours										
491	2.961	3.311			2.588	2.298	2.103	2.069	1.844	2.797
601	2.463	2.577	[not calculated]		2.457	2.902	2.103	1.561	2.268	2.383
694	1.563	1.248			2.265	3.784	2.103	1.111	2.849	1.961
total production worker hours										
491	0.965	0.640	1.026	0.900	0.834	0.607	0.956	0.819	0.898	
601	1.072	0.700	0.975	0.739	0.963	0.820	0.820	0.598	0.870	
694	0.978	0.620	0.756	0.482	1.083	1.085	0.505	0.198	0.829	
non-production worker hours										
491	0.192		0.095		0.237		0.108		0.142	
601	0.239		0.105		0.217		0.108		0.182	
694	0.305		0.096		0.243		0.108		0.244	
total hours										
491	0.708	0.440	0.930	0.815	0.745	0.528	0.863	0.727	0.773	0.681
601	1.000	0.662	0.887	0.661	0.838	0.674	0.697	0.508	0.960	0.661
694	1.370	0.852	0.679	0.352	0.947	0.865	0.384	0.151	1.221	0.633

	Non-electrical Machinery		Electrical Machinery		Transportation Equipment		Instruments	
	η_β	η_γ	η_β	η_γ	η_β	η_γ	η_β	η_γ
production worker straight-time hours								
491	0.764	0.720	0.907	0.343	0.861	0.549	0.864	0.393
601	0.94	0.556	0.936	0.516	0.966	0.685	0.428	0.450
694	1.224	0.324	0.724	0.668	0.393	0.434	0.613	0.517
overtime hours								
491	1.945	2.645	1.666	1.079	0.835	2.160	1.852	1.495
601	1.808	2.682	1.489	2.369	1.137	2.939	1.967	3.098
694	0.707	1.470	0.591	3.222	1.672	4.322	−1.576	2.083
total production worker hours								
491	0.994	1.021	0.964	0.414	0.669	0.750	0.953	0.338
601	1.035	0.777	0.973	0.653	1.133	0.859	0.940	0.674
694	1.098	0.394	0.628	0.844	1.493	0.650	0.129	0.955
non-production worker hours								
491	0.550			−0.125	0.266		0.393	
601	0.437			−0.104	0.315		0.450	
694	0.337			−0.103	0.376		0.517	
total hours								
491	0.851	0.587	0.824	0.909	0.603	0.628	0.858	0.278
601	0.891	0.729	0.790	0.464	0.952	0.689	0.803	0.465
694	0.950	0.927	0.610	0.560	1.217	0.541	0.317	0.613

TABLE XL

Long-Term Rates of Growth of Productivity
U.S. 2-Digit Manufacturing Industries
(Annual rate in per cent, calculated at 1960:1)

Industry	(1)	(2)	(3)	(4)	(5)
20	2.89	6.39	3.56	1.05	2.82
21	4.16	*	4.26	−0.41	3.74
22	4.63	1.95	4.26	0.61	4.00
23	3.18	0	3.28	2.46	3.23
24	3.69	−0.69	3.45	0.90	3.15
25	4.45	6.70	4.61	2.95	4.31
26	2.86	3.90	2.95	0.02	2.49
27	1.93	4.03	2.05	1.31	1.73
28	6.33	7.18	6.60	3.34	5.15
29	5.82	4.44	5.60	3.21	4.43
30	3.72	3.36	3.78	2.23	3.23
31	2.01	*	2.07	−0.07	1.83
32	2.79	2.39	2.83	0.23	2.38
33	2.82	0	2.28	0	1.95
34	2.38	2.09	2.34	2.58	2.20
35	2.26	3.68	2.71	0	2.19
36	3.39	6.55	3.70	0.79	2.42
37	6.04	3.28	6.08	2.13	3.65
38	5.44	10.70	5.83	1.33	4.18

NOTE: (1) Column heads same as in Table XXXVII.
(2) An asterisk indicates not calculated.

B. PRICES

MODELS ANALYZED

The price models analyzed for the U.S. combine the same mechanisms of excess demand and standard costs as for Canada, although for obvious reasons external influences (except insofar as these are reflected in changes in excess demand and materials prices) are omitted from consideration. On the other hand, the U.S. models contain a feature which, for lack of data, was absent from the Canadian models, namely, the inclusion of a variable representing the external funds required for financing new investment. The rationale for this variable is that in concentrated industries where individual firms possess elements of market power it is reasonable to suppose that in setting prices such firms keep in mind their projected investment requirements.

The model estimated is as follows:

$$\ln P_t = \alpha + \beta \ln P_{t-1} + \gamma \ln X_t + \delta_1 \Delta \ln ULC^N_t + \delta_2 \ln ULC^N_{t-1} + \lambda_1 \Delta \ln Pm_t$$
$$+ \lambda_2 \ln Pm_{t-1} + \eta \ln \left[\frac{NA}{IF_t} \right] + \xi \ln r_t + v_t , \qquad (6)$$

where

P	=	price index of output
X	=	measure of excess demand
ULC^N	=	normal unit labor cost
Pm	=	index of materials input prices
NA	=	new capital appropriations
IF	=	internal funds
r	=	yield on corporate bonds
v_t	=	random disturbance.

The functional form of equation (6) was derived and discussed in section four of chapter two, and consequently need not be considered again here. The only difference between the form of this equation and that estimated in chapter five for Canada is that $\ln ULC^N_{t-1}$ and $\ln Pm_{t-1}$ are used in place of $\ln ULC^N_t$ and $\ln Pm_t$. However, since any variable z_t can be expressed as $\Delta z_t + z_{t-1}$, the two formulations are, of course, equivalent.

DATA

Prices

The Bureau of Labor Statistics publishes wholesale price indexes for total, durable, and nondurable manufacturing, and these are the output price series used at these levels of aggregation. For materials prices, we have used the wholesale price index referring to crude materials for further processing, also published by BLS. The same index has been used for durable and nondurable manufacturing, as well as the total.[5]

At the two-digit industry level, the only quarterly price data currently available are those that have been constructed by Eckstein, Wyss and Ando.[6] On the output side, they were able to compose an index for each two-digit industry except ordnance (19), publishing (27), and miscellaneous manufacturing (39), while for transportation equipment (37), the index constructed in fact refers to motor vehicles (3711). For materials prices, the coverage is less complete, there being

[5]This measure is not ideal since it suffers the twin defects of (1) not being based on the input-output structure of manufacturing and (2) including some materials not subsequently processed in manufacturing. Nevertheless, its use is more appropriate than the only serious alternative which was available to us, which was to aggregate across materials prices indexes at the two-digit industry level. The latter would be conceptually correct provided that one nets out interindustry purchases, but because of time and resource constraints we were unable to effect the necessary netting out. To ignore it would lead to serious spurious correlation.

[6]We are indebted to Otto Eckstein and James Craig of Data Resources, Inc. for making these data available.

(in addition to industries 19, 27, and 39) no index for tobacco (21), apparel (23), lumber (24), furniture (25), paper (26), leather (31), and instruments (38). The strong results obtained for the materials price variable reported suggest that estimation of equations which omit this variable would probably be misleading. Hence no price equations were estimated where either output or input price series were not available. As in the case of the output price index, the materials prices index for transportation equipment refers to motor vehicles. Consequently, the corresponding price equation we estimate for that industry can be more appropriately interpreted as referring to motor vehicles rather than to the entire transportation equipment sector.

Inventories, New and Unfilled Orders, and Shipments

The source of these data is the Bureau of the Census of the U.S. Department of Commerce. The data are published monthly, quarterly figures being obtained through averaging.

Unit Labor Cost

The values for normal unit labor cost are calculated from the regressions tabulated in Tables XXXV and XXXVIII of this chapter in the manner described below.

New Capital Appropriations, Internal Funds, and the Yield on Corporate Bonds

Data on new capital appropriations by U.S. manufacturing corporations are collected quarterly and published by the National Industrial Conference Board. The series for internal funds is defined as the sum of retained earnings and depreciation and depletion, and are derived from the *Quarterly Financial Reports*, published jointly by the Securities Exchange Commission and the Federal Trade Commission. Finally, for the yield on corporate bonds, we have used the one for industrial corporations published by Moodys.

The data are quarterly and, with exception of the yield on corporate bonds, new capital appropriations, and internal funds, are seasonally adjusted. For all manufacturing, durables, and nondurables, the sample period, except for the equations involving finished-goods inventories (which begin with the first quarter of 1955), begins with the second quarter of 1953. The two-digit equations all begin with the first quarter of 1955. In all cases, the sample period ends with the fourth quarter of 1968.

EMPIRICAL RESULTS

The equations for prices are tabulated in Tables XLI and XLII, Table XLI referring to total manufacturing, durables, and nondurables and Table XLII to individual two-digit industries. As was noted above, equations were not estimated for tobacco, apparel, lumber, furniture, paper, printing and publishing,

and leather because of lack of data. The additional independent variables not previously defined are as follows:

$$H = \text{total inventories/shipments}$$

$$H^* = \frac{1}{8}\sum_{i=1}^{8} H_{t-i}$$

$$FG = \text{finished-goods inventories/shipments}$$

$$FG^* = \frac{1}{8}\sum_{i=1}^{8} FG_{t-i}$$

$$NO/S = \text{new orders/shipments}$$

$$UO/S = \text{unfilled orders/shipments}$$ [7]

$$ULC^C = \text{corrected unit labor cost.}$$

ULC^N is based upon unit manhour requirements predicted from the productivity equations evaluated at full utilization of capacity (and zero deviation of planned from actual output). ULC^C, on the other hand, is based on actual unit manhours requirements adjusted for cyclical and transitory factors. The differences between these two measures of unit manhour requirements depends simply upon the residuals from the productivity equations. Each unit manhours variable is then multiplied by average straight time earnings of production workers to obtain the unit labor cost variables used in the analysis.

Algebraically:

$$ULC^N = (\widehat{M/C})\cdot W, \text{ and } ULC^C = (\widehat{M/C} + \hat{\varepsilon})\cdot W,$$

where $(\widehat{M/C})$ is predicted unit manhour requirements at full utilization of capacity (and zero deviation of actual from planned output), $\hat{\varepsilon}$ is the residual from the productivity equation, and W is average straight-time earnings of production workers. In much of the discussion throughout the remainder of this chapter there is no need to distinguish between these two measures; accordingly the term normal unit labor costs will usually refer to both definitions.

Equation (1) in the tables is a standard version of equation (6) above applied uniformly across industries. It includes the measures of excess demand and normal ULC giving the best results, materials prices, external capital requirements, and the yield on corporate bonds. Equation (2) represents our final equations. In selecting these equations, variables with wrong signs (always) or with t-ratios less than one (usually) were eliminated. For stone, clay and glass, primary and fabricated metals, and nonelectrical machinery, as well as for durable manufacturing as a whole, the final equations have been estimated incorporating constraints on the size of the long-run elasticities.

Importance of Postulated Factors

Since the same model has been applied to each industry, discussion of the empirical results can usefully begin with an analysis of the model's general

[7] Note that the orders-shipments variables are not expressed relative to an eight-quarter moving average as in the Canadian equations.

performance. To this end, let us turn first to Table XLIII, which provides a summary of the statistical importance of the various components of the model—excess demand, normal unit labor cost, materials prices, the need for external funds, and the rate of interest. An x in this table signifies that the determining factor under which it falls appears in the final equation with the sign expected *a priori* and t-ratio at least one.

Excess Demand

In general, we expect the variables measuring excess demand to show up most strongly in the more competitive industries and in those concentrated industries which gear their pricing decisions to changes in demand. Moreover, for industries producing more to order than for stock, we should expect the ratio of new (or unfilled) orders to shipments to be a better barometer of demand pressure than the ratio of inventories to shipments. Finally, when inventories are the appropriate measure, we should expect finished-goods inventories to outperform the total stock of inventories since the latter also includes raw materials and goods in process.

The results present an interesting, though somewhat varied, picture. Excess demand in some form is seen to be present in the final equation for every industry with the exception of chemicals, rubber, and stone, clay and glass. Most surprising, perhaps, is that, for those cases for which both are available, total inventories in general lead to better results than do inventories of finished goods. It is only for primary metals and the two machinery industries, where they appear in conjunction with unfilled orders, that finished-goods inventories clearly hold the edge. Besides the two machinery industries, unfilled orders also show up strongly in fabricated metals, and to a weaker extent in motor vehicles. At the industry level, new orders were never as strong statistically as unfilled orders, and not infrequently their signs were negative rather than positive. Curiously enough, however, at the aggregate level, it is new orders that are the stronger.

Unit Labor Costs

The results show that normal or corrected unit labor costs are an important determinant of prices. With the exception of the equation for the non-durables sector, one or the other of these variables is at least marginally important in each industry or sector. It is perhaps noteworthy that normal unit labor costs are generally the preferred form of the variable. As is shown in Table XLIII, only in three industries does the alternative form (corrected unit labor costs) yield superior results. As is indicated by the magnitude of the regression coefficients and t-ratios in Tables XLI and XLII, it is clear that these variables are, next to materials prices, the most important predictors in the model.

Finally, we should mention that in an early stage of our analysis we estimated a number of equations in which the change in actual unit labor costs was included as a predictor as well as the change in normal unit labor cost. If pricing behavior is in fact based on a target markup over costs at some standard level

of output, then the change in actual unit labor cost should be irrelevant.[8] However, it is interesting to determine whether the deviation of actual from normal (or corrected) unit labor costs have an impact on pricing behavior in the short run. To test this, we introduce the change in actual unit labor costs as an additional independent variable in the general models. For the most part, these variables proved to be insignificant; hence the results are not tabulated.

Materials Prices

Materials prices are without question the single most important determinant of output prices. The change as well as the level of these variables is important for the three sectoral equations and for five of the equations for individual industries. In each of the remaining six industries, the change alone is important in two and the level alone in four. As will be discussed below, the elasticities of output price response with respect to changes in input prices are typically large.

External Funds Requirements

As was noted briefly earlier, the rationale for the inclusion of this variable is that in industries in which firms possess substantial market power, there will be incentive to raise prices when new capital appropriations exceed the flow of internal funds. If this reasoning is valid, we should then expect ln(NA/IF), the variable measuring these two quantities, to appear with a positive and statistically important coefficient in the industries which are highly concentrated; in the nonconcentrated industries, on the other hand, the variable should be of little importance.

The hypothesis receives support from the results, but in rather curious fashion. Ln(NA/IF) is strong statistically for all manufacturing and the durable industries as a group—quite in keeping, of course, with the reasoning just expressed—but at the industry level, it is only for chemicals and electrical machinery that ln(NA/IF) displays any spark at all. For petroleum, primary metals, and motor vehicles, the variable appears with a negative sign and, even worse, with t-ratios greater than one.

Interest Rates

The last variable to be discussed is the interest rate, as measured by the yield on corporate bonds. (It will be remembered from chapter five that the reasoning underlying inclusion of the interest rate is as a factor influencing limit pricing and also as an element of cost push.) In general, the results for this variable are stronger than for the one just discussed, since ln r is of some importance for textiles, primary metals, electrical machinery, and motor vehicles, as well as in the three final equations at the aggregate level. The sign for ln r for motor vehicles is negative rather than positive, but this should perhaps be interpreted as a demand effect arising through the impact of the interest rate on the demand for new cars.

* * * *

[8]See Eckstein and Fromm (1968).

On the whole, the statistical quality of the "final" equations in Tables XLI and XLII are very good. Most $\bar{R}^2$'s are above 0.95, and a number are above 0.99. And, with the exception of petroleum and rubber, the standard errors of estimate are all less than one per cent. However, since the equations are estimated in levels and the lagged dependent variable appears as a predictor, good fits are to be expected, and thus the high $\bar{R}^2$'s, in themselves, are not of great consequence. The size of t-ratios is of more critical importance, and, as already noted, materials prices (especially) and normal unit labor cost stand up well in this regard. Moreover, there are only a few instances of wrong sign combined with a t-ratio greater than one, and, finally, with exception of textiles, rubber, stone, clay and glass, and primary metals, auto-correlation in the residuals does not appear to be a problem.[9] On the other hand, in view of the rather large number of final equations which have been estimated with *a priori* constraints imposed on the long-run elasticities, it is quite clear that the underlying data are not without problems of multicollinearity.

General Discussion and Comparison of Aggregate Equation with Industry Results

As was found to be the case for Canada in chapter five, the results very clearly point to an eclectic mechanism of pricing behavior in U.S. manufacturing. For we find elements of competitive and oligopolistic pricing not only at the aggregate level, which we naturally expect to be the case, but at the two-digit industry level as well. On reflection, however, this should not be surprising, for these large industry groupings contain individual industries with widely varying market structures. Furthermore, the presence of normal ULC and materials prices as statistically important predictors should not be taken as an indication of oligopolistic pricing behavior, since even under pure competition, prices must ultimately reflect changes in the costs of inputs. In the long run, normal cost as we have defined it is likely to be very closely related to the average unit cost corresponding to the tangency of the plant curve to the long-run cost curve. For this reason, we should expect the variables representing normal costs to show up in competitive industries as well as oligopolistic, though in the more competitive industries, their impact may be less important in the short run.

In Table XLIV, we have tabulated the short and long-run elasticities of output price with respect to a change in normal unit labor cost and materials prices as implied by the final equations [equations (2)] in Tables XLI and XLII. Since the variables are in logarithms, the short-run elasticities are given by δ_1 and λ_1, the coefficients for $\Delta \ln ULC^N$(or ΔULC^C) and $\Delta \ln Pm_t$, while the long-run elasticities are given by $\delta_2/(1-\beta)$ and $\lambda_2/(1-\beta)$, obtained by setting $\Delta \ln ULC^N$ and $\Delta \ln Pm$ equal to zero and $\ln P_t$ equal to $\ln P_{t-1}$.

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[9]In saying this, we are well aware that in models with the lagged dependent as a predictor the Durbin-Watson coefficient is biased toward 2.

It has already been mentioned that several of the final equations—namely, those for durable manufacturing, stone, clay and glass, primary and fabricated metals, and non-electrical machinery—have been estimated with constraints imposed on the long-run elasticities. This was done whenever the long-run elasticities obtained from the coefficients unconstrained seemed implausibly large. The *a priori* values imposed have been 0.4 for the long-run elasticity with respect to normal ULC and 0.6 for materials prices. In the final equations for stone, clay and glass, primary and fabricated metals, and non-electrical machinery both long-run elasticities are so constrained, while in the one for durable manufacturing as a whole only the elasticity for normal ULC is.[10]

From Table XLIV, we see that, with exception of those instances where the long-run elasticity is equal to zero (brought about through the exclusion of $\ln ULC^N_{t-1}$ or $\ln Pm_{t-1}$ as predictors), the elasticities are always less in the short run than in the long run. This is, of course, precisely what we expect in the context of standard-cost pricing. It is also to be noted that, in general, the short-run elasticity is greater for Pm than for ULC^N, thus indicating that firms tend to adjust prices in the short run more in response to changes in materials prices than in response to changes in normal ULC.

Following the procedure in chapter five, it is of interest to aggregate across the individual industry elasticities to obtain elasticities which (at least in principle) are comparable with those in the aggregate equation. Using shipments in 1961 as weights, this procedure yields values of 0.12 and 0.33 for the short and long-run ULC^N elasticities and 0.19 and 0.53 for the materials prices elasticities. These compare with the values from the aggregate equation of zero and 0.48 for labor costs, and 0.17 and 0.29 for materials costs. The following comments are in order:

1. As was noted in chapter five, the weighted micro-elasticities with respect to ULC^N should be expected to be less than the elasticity from the aggregate equation because of the presence of some inter-industry purchases.
2. The weighted micro long-run elasticity with respect to materials prices is obviously heavily influenced by the value of 0.6 imposed *a priori* on four industries. If this value is too high, then the micro figure will necessarily be biased upward.
3. On the other hand, it can be argued that the long-run Pm elasticity from the aggregate equation is too low. Since the series used for Pm at the aggregate level is at best a good stand-in for the conceptually correct series, a downward bias could be present because of errors in variables.
4. Finally, it should be noted that the weighted micro elasticities are based upon industries which account for only about 75 per cent of shipments in 1961.

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[10]With industries 32–35, the constraint was first imposed on materials prices only, but, because of multicollinearity, this then led to implausibly large values for the LR elasticities with respect to ULC^N; thus the imposition of the double constraint.

COMPARISON WITH EXISTING STUDIES

We conclude our discussion of the empirical results by presenting a brief comparison of our results with those of two existing studies, Eckstein and Fromm(1968)and Eckstein and Wyss(1971). There are, of course, other studies,[11] but these are the two most comparable in scope with ours, for in both instances the output data analyzed have been the same.

The comparison with Eckstein and Fromm at the aggregate level requires little comment. The methodologies are very similar, the most important differences of note being that we employ a different series for materials prices[12] and include variables representing the interest rate and the need for external funds whereas Eckstein and Fromm did not. In addition, there is also a difference in the way normal ULC were constructed. Finally, Eckstein and Fromm estimated their levels equations with the variables in arithmetic units, whereas ours are estimated in logarithms.[13] In general, Eckstein and Fromm find short-run demand factors to be of greater importance than we do, but this could be the result of their not including the variables representing the interest rate and the need for external funds. However, as far as one can tell, the two sets of results regarding normal ULC and materials prices seem to be very similar.[14]

Turning now to the industry level, our methodology differs from that of Eckstein and Wyss in the following respects:

1. We have analyzed fewer industries than they. Eckstein, Wyss and Ando were not able to construct an index materials prices for every two-digit industry, and we have chosen not to estimate equations for those industries for which this index is missing. This has obviously reduced our coverage, but we feel it to be justified in view of the unquestioned importance of materials prices.
2. Because of differential data availability, our sample period 1955:1—1968:4, is shorter than that used by Eckstein and Wyss.
3. Despite the common genesis, the form of our model is different. Eckstein and Wyss define their dependent variable as the ratio of the current quarter's price level to a declining-weight four-quarter moving average of levels in the past. The purpose of this procedure, as Eckstein and Wyss put it, is "to achieve a higher signal-to-noise ratio" than can be obtained by the use of quarterly first differences (or percentage changes).

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[11]Two, in particular are Schultze and Tryon (1965) and Houthakker (1968). Schultze and Tryon follow a standard cost format, but their results are of only limited interest in the present context because of the high level of aggregation and their analysis of non-manufacturing sectors. The Houthakker paper analyzes annual data rather than quarterly and is based on the assumption of an underlying Cobb-Douglas production function. Houthakker, too, finds a strong influence of costs, but he is suspicious of the results because of the way the price data are defined.

[12]Eckstein and Fromm materials prices indexes constructed by Faith Halfter Ando in her doctoral dissertation at Harvard (1967).

[13]Eckstein and Fromm also analyzed quarterly first differences and four-quarter overlapping per cent changes.

[14]Before leaving the aggregate level, we should note the, in general, very poor results for both durables and nondurables. These stem, in our opinion, from the use of an inadequate series for materials prices.

Our model, in contrast, is of the partial adjustment variety and has the logarithm of the price level as the dependent variable.

4. Still another difference in our procedures involves the manner in which unit labor cost enters. Eckstein and Wyss simply include the raw change in average straight-time hourly earnings. The inclusion of the operating rate then allows for some correction for cyclical swings in productivity. Our procedure, which is much more in keeping with Eckstein's theoretical model, is to make this correction, via our manhour equations, on unit labor cost directly.
5. We have not made any allowances for independent influences of the economy as a whole. Eckstein and Wyss made some effort in this direction, but to little avail.
6. Finally, also unlike Eckstein and Wyss, we have not reported any results incorporating a hypothesis of target-rate-of-return pricing. In the earliest stages of our investigation, we did look into this to some extent, but in general the results made little sense. Among other things, signs on the rate-of-return variables were frequently wrong, indicating that we were probably capturing nothing more than the feedback of higher prices on profits.

Because of these differences in methodology, a comparison of our results with those of Eckstein and Wyss is rather difficult. We both find substantial elements of standard-cost pricing, and also of the influence of excess demand. However, in comparing t-ratios, we, in general, find materials prices to be of greater statistical importance for us, and unit labor cost to be of somewhat less. The latter may be a reflection of the fact that Eckstein and Wyss did not make an explicit correction for cyclical swings in productivity. As a consequence, the change in average hourly earnings may be representing demand effects as well as cost. Finally, the absence of an input price index for several of the industries that Eckstein and Wyss analyzed is, in our opinion, a serious omission, and leaves their results for the industries for which this is the case (tobacco, apparel, lumber, furniture, paper, and leather) open to question.

CONCLUSIONS

Summing up:

1. Despite the extensive variation in concentration among the industries studied, the results do not yield any dichotomization of pricing mechanisms. The industries at the bottom of the concentration scale display nearly as many elements of standard-cost pricing as those at the top. Moreover, there are only three industries, chemicals, rubber, and stone, clay, and glass, for which demand pressure in some form of another does not appear to play a role.
2. That standard-cost pricing is widespread is shown clearly by the strong performance of materials prices and the weaker, but nevertheless im-

pressive, showing of ULC^N. The results demonstrate unequivocally that pricing models which ignore these two elements are seriously incomplete.

3. With regard to the various indexes of excess demand, total inventories, except for the machinery industries, performs better than inventories of finished goods and, at the industry level, unfilled orders always performs better than new orders.
4. The industries in which the order-shipments variable is important are precisely those to be expected *a priori*, namely, those in which there is substantial production to order. Thus, in this important aspect the results are very favorable to the basic logic of the underlying model.
5. Finally, the hypothesis that firms in concentrated industries focus on the cost of capital as a barrier to entry and price accordingly receives very strong support at the aggregate level, as does also the hypothesis that such firms also price with an eye to their projected investment requirements. However, at the industry level, the evidence, especially for the latter hypothesis, is considerably more mixed.

TABLE XLI

Price Equations

U.S. Manufacturing

	C	$\ln P_{t-1}$	$\ln\left(\frac{FG}{FG^*}\right)$	$\ln\left(\frac{NO}{S}\right)$	$\Delta \ln ULC^N$	$\ln ULC^N_{t-1}$	$\Delta \ln Pm$	$\ln Pm_{t-1}$	$\ln\left(\frac{NA}{IF}\right)$	$\ln r$	$\bar{R}^2$(S.E.)	D.W.
All Manufacturing												
(1)	−0.167	0.901		0.049	0.0241	0.0476	0.171	0.0285	0.00576	0.0236	0.997	1.67
	(−2.47)	(25.31)		(2.91)	(0.33)	(1.94)	(6.17)	(2.00)	(3.18)	(2.61)	(0.00309)	
(2)	−0.171	0.899		0.0419		0.0480	0.173	0.0291	0.00601	0.0245	0.997	1.66
	(−2.60)	(26.26)		(3.09)		(1.97)	(6.37)	(2.07)	(3.68)	(2.88)	(0.00306)	
Durable Manufacturing												
(1)	−0.0443	0.913		0.0364	0.278	0.124	0.0373	0.00301	0.00657	0.0207	0.997	1.66
	(−0.49)	(33.28)		(3.46)	(3.32)	(2.87)	(0.99)	(0.15)	(2.90)	(2.04)	(0.00418)	
(2)	−0.0395	0.901		0.0313	0.262		0.0335		0.00650	0.0262	0.997	1.52
	(−2.47)	(34.56)		(3.03)	(3.08)		(0.89)		(2.82)	(2.79)	(0.00427)	
Nondurable Manufacturing												
(1)	−0.486	0.787	0.0139		0.0156	−0.0410	0.291	0.0970	0.00457	0.0230	0.983	2.00
	(−2.67)	(8.16)	(0.81)		(0.12)	(−1.38)	(7.58)	(2.69)	(2.03)	(1.89)	(0.00408)	
(2)	−0.393	0.802			0.138			0.0758		0.0251	0.981	2.06
	(−2.74)	(10.40)			(1.20)			(2.69)		(2.37)	(0.00433)	

NOTE: Equation (2) for durable manufacturing has been estimated with $\ln P_t$ replaced by $\ln P_t - .41 \ln ULC^N_{t-1}$ and $\ln P_{t-1}$ by $\ln P_{t-1} - .41 \ln ULC^N_{t-1}$. See text for explanation.

TABLE XLII

Price Equations

U.S. 2-Digit Manufacturing Industries

C	$\ln P_{t-1}$	$\ln\left(\frac{H}{H^*}\right)$	$\Delta \ln ULC^C$	$\ln ULC^C_{t-1}$	$\Delta \ln ULC^N$	$\ln ULC^N_{t-1}$	$\Delta \ln Pm$	$\ln Pm_{t-1}$	$\ln\left(\frac{NA}{IF}\right)$	$\ln r$	$\bar{R}^2$(S.E.)	DW
20 Food												
(1) 0.0214	0.670	−0.0423			0.0647	0.0770	0.478	0.207	0.00357	−0.00588	0.982	2.21
(0.73)	(7.14)	(−0.83)			(0.59)	(3.00)	(6.72)	(2.97)	(0.65)	(−0.32)	(0.00825)	
(2) 0.0096	0.665	−0.0444			0.107	0.0741	0.478	0.202			0.981	2.25
(2.72)	(7.25)	(−0.90)			(1.31)	(3.53)	(7.04)	(3.01)			(0.00813)	
22 Textiles												
(1) −0.0253	0.883	−0.101			0.236	0.0834	0.155	−0.0289	−0.00129	0.0154	0.912	1.42
(−1.86)	(15.13)	(−6.46)			(2.80)	(2.66)	(1.86)	(−0.47)	(−0.50)	(1.64)	(0.00576)	
(2) −0.0268	0.888	−0.102			0.238	0.0743	0.172			0.0179	0.911	1.40
(−2.91)	(16.46)	(−7.03)			(2.89)	(3.29)	(2.26)			(3.11)	(0.00567)	
28 Chemicals												
(1) −0.0143	0.857	0.0201	−0.0785	0.0287			−0.00515	0.0245	0.00234	0.00799	0.951	1.80
(−0.81)	(11.24)	(2.22)	(−0.18)	(1.91)			(−0.07)	(0.74)	(1.02)	(0.70)	(0.00333)	
(2) −0.00216	0.948			0.0127				0.0373	0.00474		0.946	1.67
(−0.12)	(15.89)			(1.28)				(1.78)	(2.48)		(0.00337)	
29 Petroleum												
(1) −0.0154	0.844	−0.179			0.492	0.0325	1.0585	0.0452	−0.00506	0.0110	0.860	2.16
(−0.36)	(8.81)	(−2.79)			(2.28)	(0.74)	(4.29)	(0.38)	(−1.09)	(0.40)	(0.0147)	
(2) −0.000333	0.893	−0.172			0.368		0.960				0.854	2.12
(−0.12)	(11.48)	(−3.02)			(1.93)		(4.55)				(0.0144)	
30 Rubber												
(1) 0.0134	1.008	−0.0577			−0.0481	−0.320	−0.0732	0.287	−0.00229	−0.00795	0.874	1.45
(0.39)	(12.02)	(−1.64)			(−0.24)	(−2.10)	(−0.28)	(2.23)	(0.39)	(−0.37)	(0.0137)	
(2) −0.00193	0.889	−0.0170			0.171			0.0597			0.860	1.23
(−0.63)	(16.48)	(−0.61)			(0.99)			(1.23)			(0.0139)	

	C	$\ln P_{t-1}$	$\ln\left(\frac{H}{H^*}\right)$	$\ln\left(\frac{FG}{FG^*}\right)$	$\ln\left(\frac{UO}{S}\right)$	$\Delta\ln ULC^C$	$\ln ULC^C_{t-1}$	$\Delta\ln ULC^N$	$\ln ULC^N_{t-1}$	$\Delta\ln Pm$	$\ln Pm_{t-1}$	$\ln\left(\frac{NA}{IF}\right)$	$\ln r$	$\bar{R}^2$ (S.E.)	DW
32 Stone, Clay and Glass															
(1)	0.0153	0.669	−0.0156			0.0711	0.0885			0.0865	0.417	0.00460	−0.00731	0.996	1.50
	(0.90)	(16.53)	(−2.07)			(1.69)	(1.72)			(0.60)	(5.23)	(0.41)	(−0.63)	(0.00324)	
(2)	0.00326	0.921				0.0791				0.409				0.963	1.30
	(4.19)	(33.34)				(1.89)				(2.67)				(0.00430)	
33 Primary Metals															
(1)	−0.0358	0.834		−0.0139		0.00909	−0.0222			0.408	0.171	−0.00170	0.0280	0.991	1.26
	(−1.45)	(13.32)		(−2.55)		(0.18)	(−0.48)			(3.51)	(3.51)	(−0.81)	(1.64)	(0.00564)	
(2)	−0.00753	0.845		−0.0144		0.0803				0.391			0.0101	0.054	1.13
	(−0.56)	(13.75)		(−2.62)		(1.90)				(5.45)			(1.03)	(0.00584)	
34 Fabricated Metals															
(1)	−0.0152	0.919			0.0216			0.236	0.0994	0.491	0.0389	0.00021	0.00065	0.996	1.92
	(0.75)	(16.83)			(1.70)			(2.05)	(0.69)	(3.41)	(0.55)	(0.20)	(−0.01)	(0.00412)	
(2)	−0.0111	0.957			0.0151			0.220		0.427				0.972	1.97
	(−2.27)	(30.07)			(2.58)			(2.48)		(3.69				(0.00402)	
35 Non-electrical Machinery															
(1)	−0.0191	0.977			0.0149			0.161	0.0305	0.505	0.0256	−0.00231	0.00351	0.999	1.77
	(−1.18)	(35.95)			(2.75)			(1.79)	(0.41)	(4.12)	(0.53)	(−1.65)	(0.33)	(0.00303)	
(2)	−0.0152	1.005		−0.00815	0.0167			0.131		0.386				0.995	1.77
	(−2.97)	(95.51)		(−1.11)	(3.62)			(1.70)		(3.55)				(0.00307)	
36 Electrical Machinery															
(1)	−0.127	0.791			0.0432			0.0562	0.0827	−0.326	−0.0339	0.00233	0.0478	0.973	1.99
	(−3.32)	(14.65)			(4.05)			(0.84)	(1.27)	(−2.11)	(−1.31)	(0.93)	(2.36)	(0.00533)	
(2)	−0.0567	0.863		−0.0160	0.0409				0.0740		0.0813			0.969	1.93
	(−4.69)	(23.87)		(−1.48)	(4.53)				(1.24)		(4.16)			(0.00547)	
3711 Motor Vehicles															
(1)	0.0175	0.798			0.00528	0.0764	0.0585			0.0644	0.169	0.00341	−0.0199	0.987	2.02
	(0.62)	(13.45)			(0.90)	(1.87)	(1.60)			(−0.30)	(2.45)	(−1.87)	(−1.16)	(0.00527)	
(2)	−0.0127	0.868			0.00767	0.0578								0.986	
	(−1.50)	(19.35)			(1.33)	(1.44)								(0.00537)	

NOTE: Equations (2) for industries 32–35 have been estimated with $\ln P_t$ replaced by $\ln P_t - 0.4 \ln ULC^{N(C)}_{t-1} - 0.6 \ln Pm_{t-1}$ and $\ln P_{t-1}$ by $\ln P_{t-1} - 0.4 \ln ULC^{N(C)}_{t-1} - 0.6 \ln Pm_{t-1}$. See text for explanation.

Table XLIII

Summary of Price Models

(an x indicates t-ratio ≥ 1)

industry	excess demand: inventories	excess demand: orders	unit labor cost: change	unit labor cost: level	materials prices: change	materials prices: level	internal funds	rate of interest
all manufacturing		x		x	x	x	x	x
durable manufacturing		x	x	x	x	x	x	x
nondurable manufacturing		x			x	x	x	x
food	x		x	x	x	x		
textiles	x		x	x	x			x
chemicals				x		x	x	
petroleum	x		x		x			
rubber			x			x		
stone, clay, glass			x*	x*	x	x		
primary metals	x		x*		x	x		x
fabricated metals		x	x	x	x	x		
non-electrical machinery	x*	x	x	x	x	x		
electrical machinery	x*	x		x		x		
motor vehicles		x	x	x*		x		

Note: (1) An asterisk under inventories indicates finished-goods inventories as opposed to total inventories.

(2) As asterisk under unit labor cost indicates that corrected rather than normal unit costs have been used.

Table XLIV

Output Price Elasticities

industry	normal unit labor cost: short run	normal unit labor cost: long run	materials prices: short run	materials prices: long run
all manufacturing	0	0.48	0.17	0.29
durable manufacturing	0.26	0.40	0.03	0
nondurable manufacturing	0.14	0	0.08	0
food	0.11	0.22	0.48	0.60
textiles	0.24	0.66	0.18	0
chemicals	0	0.24	0	0.72
petroleum	0.37	0	0.96	0
rubber	0.17	0	0	0.54
stone, clay, glass	0.07	0.40	0.40	0.60
primary metals	0.08	0.40	0.39	0.60
fabricated metals	0.22	0.40	0.43	0.60
non-electrical machinery	0.13	0.40	0.39	0.60
electrical machinery	0	0.54	0	0.59
motor vehicles	0.06	0.39	0	0.57

Note: The numbers in this table are calculated from equations (2) in Tables XLI and XLII.

chapter eight

INTERNATIONAL LINKAGES

CHANNELS OF INTERNATIONAL INFLUENCE

In this chapter we examine the strength of direct wage-price linkages between Canada and the U.S. The strength of such international influences on wages and prices in Canada has been of continuing concern to both researchers and policy-makers. At one extreme is the view that these linkages are so strong that an independent domestic policy—at least one aimed at reducing inflation—must be abandoned. At the other extreme it is argued that an appropriate exchange rate system will completely insulate the Canadian economy from inflationary forces abroad.

As is common in such controversies, the available empirical evidence suggests that a position between these extreme views is appropriate, without denying the importance of adopting a flexible exchange rate system to attain the maximum insulation from inflationary pressures from abroad. We shall return to the empirical work of previous writers after we have considered the implications of our own results. Before doing so, however, it will be worthwhile reviewing the alternative channels through which international prices and wages may affect prices and wages in Canada.

Five such channels may be identified:

1. Aggregate demand effects resulting from the effects of increases in foreign prices upon the demand for Canadian exports and upon the substitution of domestically produced goods for imports.
2. Induced monetary effects resulting from changes in the balance of payments. While these effects may be strongest under a formally fixed

exchange rate system, monetary policy may be partly endogenous under flexible as well as fixed exchange rates. A key factor affecting monetary conditions in Canada is interest rates in the U.S., which in turn will be affected by the rate of price inflation in that country.

3. Cost-push effects resulting from the increase in the price of imports. These include direct effects of foreign produced items which are delivered to final purchasers, and indirect effects reflecting the rise in costs of imported components and materials.
4. Direct influences upon prices set by Canadian firms. For a limited number of commodities, an effective world market exists, in which the Canadian price is obtained by adjusting the world price for the Canadian exchange rate, tariffs and transportation costs. Within manufacturing, this kind of market is perhaps illustrated by newsprint and pulp, which are important outputs of the paper industries, but it may also occur in certain textiles and wood products. Much more important in the manufacturing sector, is the situation in which Canadian manufacturers follow entry limit pricing policies. Where the main threat of new entry (or expansion) into the domestic market is posed by foreign products, increases in the price of foreign products will raise the entry limit price, thereby inducing price increases by Canadian firms even in the absence of any increase in their costs or in the demand for their output at the existing price.
5. Direct influences upon wages negotiated by firms and unions in Canada. As was discussed in chapter two, the rationale for such an influence is three-fold:
   (a) because of close institutional, ownership, and market links in many sectors, wage bargains in the U.S. may establish a target for Canadian wage demands;
   (b) in some sectors the objective of wage parity has become a part of union strategy, and evidence exists to support its importance in three key sectors.[1] Where wage parity is an objective, increases in U.S. wage rates may be anticipated to spur Canadian wage demands;
   (c) for those sectors where import limit pricing prevails, increases in wages abroad will encourage larger wage settlements in Canada, since firms and unions may anticipate that rising costs will be more readily passed forward in higher prices.

While each of these five channels may be of importance, particularly under inflexible exchange rates, the policy problems they pose are quite different. Direct wage and price influences (channels four and five) together with the cost-push influences (channel three) give rise to additional inflationary pressures at prevailing levels of employment and output. This would place the policy

[1]See Downie (1970).

maker on the horns of the trade-off dilemma: the importation of inflation via these channels may be halted only by reducing aggregate demand and generating increased unemployment and reduced output. Moreover, as will be discussed below, these inflationary pressures may not be easily blunted by appropriate exchange rate adjustments.

In contrast, the inflationary effects through channels one and two are accompanied by *increased* output and employment. These inflationary effects can therefore be blunted by appropriate macroeconomic counter measures, without causing a worsening of the existing unemployment situation.

Many previous studies bearing upon these issues have involved econometric work at the macro level. Unfortunately, at this level it is difficult to measure the strength of the inflationary impulses flowing through these alternative channels. Aggregate equations should therefore be interpreted as representing a blend of these effects.

To the econometrician, the problem at the macro level involves the problem of multi-collinearity among the set of potential independent variables. This is illustrated by an equation reported in a footnote in the well-known study by Bodkin *et al.* (1966).[2] In this equation the consumer price index in Canada is explained wholly by variables in the U.S. It is particularly interesting that the goodness of fit of this curioso is almost identical with that of the equation they actually select, which allows for the influence of domestic costs as well as for U.S. price influences. Yet the policy implications of these two equations differ radically, the equation with U.S. variables suggesting that the Phillips curve in Canada is a *horizontal* straight line, so that domestic policy could focus on the employment and real output objectives and ignore the price level objective.

As Caves, Reuber *et al.* (1971) have cogently argued, the problem is whether the observed close correspondence of behavior at the macroeconomic level reflects mainly common macroeconomic policies and common macroeconomic influences or whether it reflects the strength of direct wage and price linkages at the industry level. They, like us, decided that research on wage and price behavior at the industry level was required to shed light on this important issue. We compare their results with our own later in this chapter.

CALCULATIONS OF EFFECTS OF U.S. WAGES AND PRICES

For the reader's convenience, we have drawn a flowchart (Figure 1) showing how international wages and prices impinge on our system of equations under conditions of constant demand in both product and labor markets. This diagram is a convenient representation of the main interactions in our system (aside from demand effects). It illustrates in schematic form the framework within which we shall analyze the effects of changes in U.S. wages and prices under conditions where demand in product and labor markets is maintained at constant

[2]Bodkin *et al.* (1966), note 1, page 148.

levels. Of course, in the absence of countervailing policies, one would anticipate that changes in prices, wages and other components of cost will not leave demands unchanged in either market. However, in the absence of an explicit model determining orders, inventories, and output, we cannot examine the system when demand conditions change. The exercise we carry out is useful, nevertheless, since it represents the domestic inflationary effects of foreign price and wage increases when policy makers choose to neutralize their effect on output and employment. Consequently, it indicates the shifting of the inflation-real output/employment trade-off resulting from inflationary developments abroad.

The main avenues of influence in the diagram can be readily explained. First there is a set of relations derived from the equation explaining wages. Second there is a set of relations derived from the equation explaining prices of manufacturing products. Third, we make use of three identities:

(a) the identity that the consumer price index is made up, in part, of the outputs of the manufacturing sector of items included in our purchased input price index, and of imports. We assume that the direct and indirect weights of these components in the consumer price index may be used to represent the impact of their prices upon consumer prices,

(b) the identity linking changes in gross profits to changes in prices and in the various components of unit cost, and

(c) the identity linking levels of profits to changes in profits and their previous level.

As is noted on the flowchart, the main econometric linkages all involve distributed lags. This means, of course, that the results will be affected by the time span over which the impact of foreign prices on wages is measured.

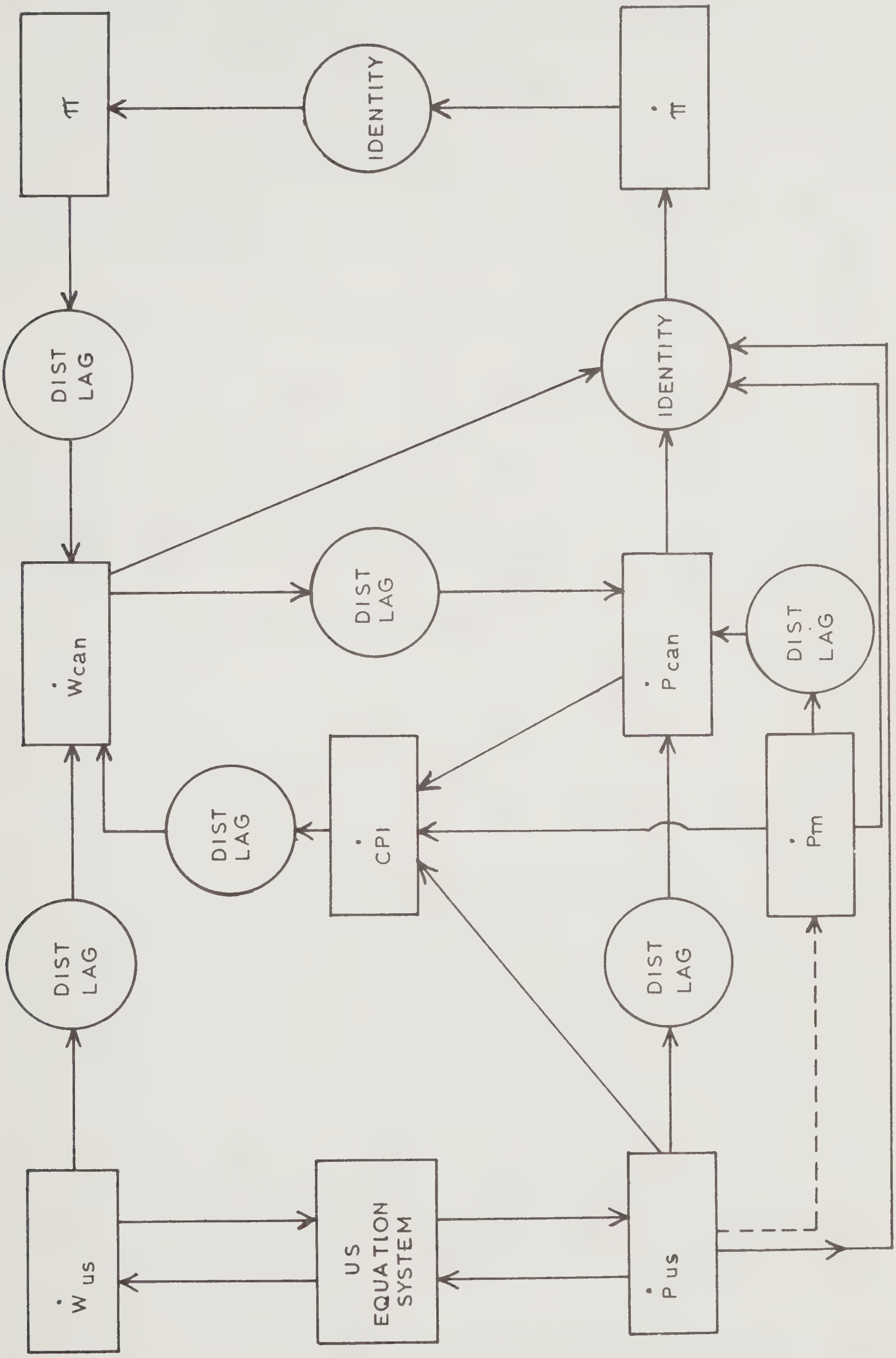
The ideal way of examining the implications of our equations would be through simulation of the system of preferred industry equations. Not only would this permit specific dynamic paths of the relevant aggregate variables to be generated, but also it would reveal the impact of foreign inflation on the inter-industry structure of wages and prices in Canada. Unfortunately, time and resource limitations precluded such research at the present time.

In the absence of such a simulation analysis of the individual industry equations, we carry out two sets of calculations. The first set is based on the wage and price equations obtained for the manufacturing sector as a whole; the second set is based on aggregations of the relevant coefficients from the wage and price equations for individual industries.

For each set we have calculated the impact of a one per cent rate of inflation of both U.S. prices and wages upon manufacturing prices and wages in Canada under alternative assumptions about the time span and the effects on other prices in Canada. Four calculations were carried out in each set. The first is simply the direct short-run impact upon negotiated wage rates and prices in Canadian manufacturing, with no allowance being made for effects on other prices, and ignoring the interaction of wages and prices within the manufacturing

FIGURE 1

Flowchart of Directions of International Direct Wage and Price Influences in Our System of Equations



– – –Avenue of possible influence, depending on assumptions about inflation in the U.S

N.B. This chart does not represent demand influences in either labor or product markets. Hence it represents the mechanism of international wage and price transmission at given levels of employment to output.

sector. Hence this calculation represents the direct immediate influence of inflation in U.S. manufacturing upon inflation in Canadian manufacturing.

The remaining three calculations all assume that sufficient time has elapsed for the inflation of wages and prices to settle down to steady state rates—hence they represent the "long run" effects of foreign inflation under alternative assumptions. The second calculation represents the long-run effects when neither the purchased input prices nor consumer prices are affected by inflation abroad. The third allows for effects on consumer prices, and the fourth for effects on raw materials prices as well as consumer prices. Hence each of the latter three calculations involves different assumptions about the breadth of inflation in the U.S. as well as different assumptions about international linkages outside the manufacturing sector.

To be more specific, we first solve the following system of equations:

$$\dot{W} = \alpha_1\dot{P} + \beta_1\dot{W}us + \gamma_1 C\dot{P}I + Z_1\text{, and}$$
$$\dot{P} = \alpha_2\dot{W} + \beta_2\dot{P}us + \gamma_1\dot{P}m + Z_2\text{,}$$

where Z_1 and Z_2 represent the effects of the other variables in the system.

We therefore obtain reduced form equations for $\dot{W}$ and $\dot{P}$ in terms of $\dot{W}us$, $\dot{P}us$, $\dot{P}m$, $C\dot{P}I$, Z_1 and Z_2. Wage and price effects under the second calculation discussed in the text are simply the sum of the coefficients on $\dot{P}us$ and $\dot{W}us$ in each of these reduced form equations.

For the remaining calculations we add the following equation:

$$C\dot{P}I = \alpha_3\dot{P} + \beta_3\dot{P}us$$

where α_3 and β_3 represent the weights of manufacturing output and imports in the CPI.

We then solve the resulting three equation system for $\dot{P}$, $\dot{W}$, and $C\dot{P}I$ in terms of $\dot{W}us$, $\dot{P}us$, $\dot{P}m$, Z_1 and Z_2.

Wage and price effects under the third calculation are simply the sum of the coefficients on $\dot{P}us$ and $\dot{W}us$ from the relevant reduced form equations.

The fourth calculation is obtained by adding to the above the effects of U.S. prices on $\dot{P}m$—we assume that the goods component of $\dot{P}m$ but not the services component rises in proportion to the increase in U.S. prices. Multiplying the weight of goods in $\dot{P}m$ by the reduced form coefficient for that variable and adding it to the reduced form coefficients for $\dot{P}us$ and $\dot{W}us$ yields the required result.

In the first set of calculations, denoted by A in Table XLV, α_1, α_2, β_1, β_2, γ_1 and γ_2 are long-run elasticities derived from the preferred wage and price equations for the manufacturing sector as a whole. In the second set, denoted by an I in Table XLV, these coefficients are derived by aggregating the corresponding elasticities based on the preferred wage and price equations for the major groups industries.

In the absence of models of wage and price determination in the non-manufacturing sectors of the Canadian economy, it is, of course, impossible to

determine which of the above calculations provides the best approximation to reality. We have a slight preference for the fourth calculation in that we think it reasonable to make allowances for strong international effects on raw materials prices. The second calculation, which makes no allowance for effects on either consumer prices or raw materials prices, is very artificial, and is included only for expository purposes in order to highlight the importance of allowing for the interaction of wages and prices within the system.

TABLE XLV

Estimated Impacts of Inflation Abroad Upon Wage and Price Behavior in Canadian Manufacturing Under Alternative Assumptions

		Effects of 1% Change in International Prices and Wages on:				Implied Change in Profit Markups[c]
Assumptions	Basis[b]	Wages	Prices	CPI	Pm	
1. Short-Run Direct Effects[a]	A	0.432	0.431	*	*	**
	I	0.403	0.218	*	*	**
2. Long-Run Effects Including Wage-Price Interaction	A	0.432	0.469	*	*	0.216
	I	0.403	0.371	*	*	0.165
3. Long-Run Effects Including CPI Effects[d] and Wage-Price Interaction	A	0.713	0.591	0.266	*	0.284
	I	0.580	0.432	0.221	*	0.169
4. Long-Run Effects Including CIP Effects, Raw Material Price Effects[e] and Wage-Price Interaction	A	0.757	0.698	0.307	0.546	0.131
	I	0.630	0.613	0.282	0.546	0.088

[a]For wages, these are the effects on currently negotiated wage rates. The short-run effects on earnings in the current quarter will be much smaller because of the contract lag.

[b]A indicates that the calculations are based on the aggregate equations for the manufacturing sector. I indicates that the calculations are based on averages of the relevant elasticities based on the preferred individual industry equations.

[c]The implied percentage change in the profit markup on unit costs is defined as follows: $\dot{K} - \dot{P} - \dot{C}$, where K = P/C is the profit markup factor, and C represents total unit costs. $\dot{C}$ is calculated as a weighted average of $\dot{W}$, $\dot{P}us$ and $\dot{P}m$, with the weights proportionate to the relative importance of labor costs, imports of manufacturing products and purchased inputs of non-manufactured products from Table XXIX of chapter five.

[d]The relative importance of manufacturing output in consumer purchases (net of direct imports) is 0.292. Direct imports and indirect imports (excluding indirect imports of manufactured products, to avoid double counting) accounted for 0.093 of each dollar of consumer expenditures. The relative importance of direct purchases of raw materials by consumers (mainly agricultural products) is 0.015. These calculations are based on data tabulations provided by R. B. Hoffman of the Input-Output Research and Development Division of Statistics Canada.

[e]The relative importance of services in the purchased inputs of manufactured products is 0.454. See also section 3 of the Appendix.

*indicates that a zero impact is assumed

**the short-run effects on profit margins cannot be calculated from the elasticities shown. See [a].

The results of these two sets of calculations are presented in Table XLV. Both sets show that the strength of these direct international wage and price influences is substantial. Even if no allowance is made for the effects of the inflation on consumer prices and prices of raw materials, wages and prices in manufacturing will rise by about four tenths of one percent. When reasonable allowance is made for the effects of the inflation on consumer prices and raw materials prices, the domestic inflationary consequences are naturally increased. Under these circumstances, the manufacturing sector equations imply a long-run wage impact of 0.76 and a price impact of 0.70. The aggregation of individual industries implies slightly lower increases in the rates of inflation of 0.63 and 0.61 respectively. However, since our aggregation procedures ignore the inter-industry wage effects, they no doubt understate the inflationary implications of the industry equation results. Hence we may view the two sets of results as being roughly comparable.

These results, then, support the conclusion that there are very strong direct and indirect international influences upon wages and prices in the manufacturing sector of Canadian industry which work through the last three channels enumerated above. Unless inflation abroad may be neutralized by exchange rate changes (and we shall examine the feasibility of this below) each percentage point of inflation (of both wages and prices) in the U.S. may be expected, after a period of adjustment, to lead to a rate of inflation of wages and prices in Canadian manufacturing of about three quarters of one per cent, provided that the aggregate demand effects of the foreign inflation are neutralized. To offset the inflationary effects of U.S. wage and price increases without exchange rate adjustments would require an increase in unemployment and a reduction in real output. Note further that, under fixed exchange rates, a continuing *increase* in unemployment may be required to neutralize the inflationary impulses from abroad. Hence the resumption of strong inflation at high but declining unemployment levels is entirely explicable in the context of this model.

In none of these calculations do we make allowance for the impact of price and wage changes upon profit rates and for any subsequent effect of profits on wages and hence on prices. Since prices, wages, and other components of unit cost are linked to profits by an identity, in principle we should make allowance for such effects. In order to assess the importance of this omission, the changes in profit rates (in the absence of offsetting effects, such as changes in corporate tax rates) implied by the three long-run calculations are shown in the last column of Table XLV. These indicate that inflation abroad will tend to increase profit margins somewhat and hence add an additional inflationary impulse to wages and prices. These results therefore indicate that a small positive adjustment would be required if allowance were made for the effects of changes in profit rates upon wage rates of increase.

So far we have examined the strength of the inflationary impulse generated by inflation abroad under conditions of fixed demand and inflexible exchange rates. We now consider the extent to which changes in exchange rates might alter these results.

One difference in our formulation of the international linkages for wages and prices should be noted. Whereas U.S. prices are adjusted for exchange rate changes, U.S. wages are not. This formulation of the wage transmission mechanism follows that of previous writers.[3] Given the importance of institutional links, pattern bargaining, and notions of wage parity expressed in nominal units as reasons for the importance of U.S. wage changes, we feel that the use of the wage rate unadjusted for variations in exchange rates is probably appropriate.[4]

Our specification of the price effects may be questioned on the basis of the work of several previous writers.[5] However, we feel that the theoretical underpinning of entry limit pricing is crucial to the understanding of international price transmission. Given this theory, it is clear that in the long run, exchange rate adjustments have effects equivalent to foreign price adjustments. While the short-run impacts may differ because of differing elasticities of expectations concerning future changes,[6] this is no reason to omit the exchange rate adjustment in the long run. Instead it suggests that a moving average of exchange rates over several periods, rather than the current rate alone, should be used as the adjustment factor, and this is what we have done.[7] Our decision here has received independent support in a recent unpublished dissertation by Don McFetridge,[8] who has carried out an analysis of price determination in a selection of three-digit industries. McFetridge found that where international prices are important, they typically should be adjusted by the exchange rate. Of 13 industries in which U.S. prices entered his preferred equation, the price unadjusted for exchange rates proved superior in only two. That this result differs from the earlier results of Caves and Reuber is not at all surprising, since they made no allowance for labor costs, domestic input prices, or excess demand in their equations.

While we feel that the use of adjusted prices is appropriate, we nevertheless recognize that the use of fully adjusted prices represents a polar case. As a result, in the experiments reported in Table XLVI, the extent to which exchange rate adjustments succeed in insulating the wage-price system in Canada may be overstated.

One other qualification should be noted. In the short run, exchange rate adjustments will be ineffective in insulating wages and prices in Canadian manufacturing, because of the long moving average applied to the exchange rate adjustment. As a result, a dynamic simulation of the system of equations might well yield results that differ significantly from the steady-state rates calculated

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[3]See Caves-Reuber (1971), Bodkin *et al.* (1966).

[4]We have not, however, estimated wage functions with U.S. wage rates adjusted for exchange rate changes.Cragg (1971) found, on the basis of simple correlation analysis, that the correlation between unadjusted wage rates was higher than that between adjusted wage rates.

[5]Cragg (1971), Dunn (1970), Caves-Reuber (1971).

[6]This is a point well documented by Caves and Reuber (1971).

[7]As noted in chapter five, in preliminary work we experimented with a variety of moving averages· as well as using the current rate, and selected a sixteen-quarter moving average of the exchange rate·

[8]D. G. McFetridge. *Market Structure and Price Behavior: Empirical Studies of the Canadian Manufacturing Sector.* Unpublished doctoral dissertation, University of Toronto, 1972.

Table XLVI

Analysis of Effects of Changes in Exchange Rates when U.S. Wages and Prices Rise 1%

Calculation*	Basis	Exchange Rate Appreciation (per cent)	Net Effects of U.S. Inflation on Manufacturing	
			Wages	Prices
1. Appreciation of 1%	A	1.00	0.50	0.22
	I	1.00	0.44	0.15
2. Appreciation Sufficient to Maintain Relative Prices of	A	0.58	0.61	0.42
Canadian and U.S. Manufactured Goods	I	0.75	0.48	0.25

*In these calculations we make allowance for the effects of U.S. prices on purchased input prices, and take into account the interactions among manufacturing wages, manufacturing prices and consumer prices. Hence they correspond to the results presented under assumption (4) in Table XLV.

below. Given the strong persistence of inflationary pressures, it may take a long period, if ever, for the "insulation" to be achieved.

Having stated the qualifications, let us now explain the calculations. The first calculation examines the effect of a one per cent appreciation of the Canadian dollar designed to neutralize the postulated one per cent inflation abroad. The results indicate that such an appreciation will not neutralize domestic inflation even in the very long run. Hence such an appreciation, if attempted, would involve the deterioration of Canada's international competitive position in manufacturing.

The second calculation examines the effects of the inflation of U.S. wages and prices if the exchange rate is adjusted so that the Canadian price of manufactured products is equal to the U.S. price adjusted for the exchange rate. These results are shown in the second half of Table XLVI. Under these conditions, a rate of appreciation of the dollar of about 0.6–0.7 per cent would occur, indicating that 60 to 70 per cent of the inflationary impulse from abroad upon prices would be neutralized. Since, as noted above, these calculations probably overstate the extent of insulation which is possible over a realistic time span, they indicate that a floating exchange rate may not be sufficient to insulate fully the Canadian economy from persistent inflationary shocks from abroad.

So far we have focussed our attention on the magnitude of inflationary impulses at the level of the manufacturing sector as a whole. It is time now to consider the breadth as well as the depth of the international linkages of wages and prices. This is done in Table XLVII, which is based on the preferred equations for wages and prices for each industry.

One thing that stands out in this table is that direct influences are far more widespread in the case of prices than in the case of wages. Whereas U.S. prices

Table XLVII

International Linkages: Direct Effects Based on Preferred Industry Equations

Industry	Wage Elasticities	Price Elasticities SR	Price Elasticities LR*
01 Food and Beverages	0.501	0.181	0.125
02 Tobacco	—	0.080	1.73
03 Rubber	—	0.617	0.217
04 Leather	—	0.114	0.184
05 Textiles	0.495	0.453	0.205
06 Apparel	—	0.179	0.325
07 Wood Industries	—	0.885	—
08 Paper	0.409	0.453	0.205
09 Printing and Publishing	0.942	NA	NA
10 Metal Products	0.747	0.146	0.381
11 Transportation Equipment	0.414	—	—
14 Non-Metallic Minerals	—	0.146	0.381
15 Petroleum and Coal	—	0.101	0.171
16 Chemicals	—	—	—
17 Miscellaneous	NA	NA	NA
Weighted Average of Above	0.403	0.218	0.233
Manufacturing Sector Equation	0.432	0.431	0.282

* These long-run effects ignore wage-price interactions and other indirect effects.
— indicates that the relevant variable is omitted from the preferred equation.
NA indicates that a required data series is not available.

play a role in the determination of domestic prices in 11 of 13 industries,[9] U.S. wages play a role in the determination of domestic wages in only six of 14 industries.[10] However, U.S. wages are significant for the two largest industries and the coefficients on U.S. wages in the wage equation are typically larger than the coefficient on U.S. prices in the corresponding price equation. As a result, the aggregation of the wage elasticities yields a larger estimated total elasticity than does the aggregation of the individual price elasticities.

It is noteworthy that three of the industries (paper, metals, and transportation equipment) for which U.S. wage changes are important, are those which Downie[11] found to have important international linkages on the basis of a careful consideration of wage contracts and institutional factors.

Another point worth stressing here is that the wage effects become distributed across industries as successive bargaining periods elapse because of the inter-industry wage influences. In other words, inter-industry spillovers disperse the direct international wage effects from these six industries into most of the remaining industries.

Whereas the aggregation of the international wage effects yields a result very close to the coefficient for the manufacturing sector equation, the aggregation

[9] Note that we exclude printing because no price data are available, and miscellaneous because no comparable U.S. data are available.

[10] We omit miscellaneous in this comparison, since comparable U.S. wage data are not available.

[11] See Downie (1970).

of the industry price effects yields results lower than the corresponding coefficient for the manufacturing sector as a whole. This result no doubt reflects the fact that the input price index for the manufacturing products, and hence the effects of changes in input prices is to some extent reflected in the coefficient on U.S. manufactured prices. In contrast, the input prices at the industry level include the effects of prices of manufacturing inputs from other sectors.[12]

COMPARISON WITH PREVIOUS STUDIES

Since we conclude, on the basis of our empirical results, that international linkages are of great importance, it is worth comparing our results with those of previous writers, with a view to noting comparabilities and explaining differences. We first examine a study which deals with the problem at the industry level, and then conclude this section with a brief discussion of three of the more prominent aggregative results.

The most comprehensive published study of international wage and price linkages is that of Caves, Reuber *et al.* (1971).[13] They examined the effects of U.S. prices on Canadian prices in 50 three or four-digit industries and of U.S. wages on Canadian wages in 27 such industries over the period 1951-62. Statistically significant price linkages were found in about 16 of the 50 industries; significant wage linkages in only three of the 27 industries. Perhaps more illuminating, however, than the counting of significant industries, is the averaging of the relevant coefficients. Averages based on suppressing or including negative coefficients are shown below in Table XLVIII.

The price effects they obtain are somewhat greater than the effects we obtain and the wage effects somewhat lower. Their model of price determination makes no allowance for either excess demand or domestic costs. Since, in the absence of these other variables, international prices may be a proxy for their influence, this could account for the average of their coefficients being somewhat larger than ours.

As for their wage results, the absence of other variables which we find important—profits, labor market demand conditions, and consumer prices—no doubt also affects the coefficients obtained for the U.S. wage variable. Perhaps more important than the omission of such variables is the misspecification of the lag structure. It is interesting that they find a finite lag of six months to yield somewhat superior results to a simultaneous specification; however, a fixed finite lag will probably be a poor approximation to a variable distributed lag.

However, in view of the differences in the specification of the industry models estimated, it is perhaps surprising that the wage and price results obtained are so close. We now turn to the aggregative studies.

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12 A minor bias may remain in that intra-sectoral purchases are excluded (and hence no allowance is made for inputs purchased from the corresponding industry abroad).

13 See in particular Chapter 5, which is based on Curtis, John M. *Direct U.S. Influence on Canadian Prices and Wages: A Disaggregated Study.* Unpublished doctoral dissertation, Harvard University, 1969.

TABLE XLVIII

Short-Run Influence of U.S. Wages and Prices at the Industry Level: A Comparison of Our Results with those of Caves and Reuber

Source	Variable	Aggregation Technique	Average Impact of Corresponding U. S. Variable
Present Study	Wages	Weighted Average	0.40
Caves-Reuber Study	Wages*	Simple Average	0.32
		Simple Average with Negative Coefficients Suppressed	0.42
Present Study	Prices**	Weighted Average	0.21
Caves-Reuber Study	Prices	Simple Average	0.51
		Simple Average with Negative coefficients Suppressed	0.54

* The results with a six month lag are used in these calculations. Average coefficients for U.S. wages with a zero lag were 0.15 (0.35 if negative coefficients are suppressed).

** These are the short-run price elasticities of the preferred price equations reported in chapter five above.

For comparative purposes, we have selected three studies: the well-known study by Bodkin, Bond, Reuber, and Robinson (1966), and the wage-price sectors of two large-scale econometric models—the experimental quarterly model (RDX1) published by the Bank of Canada, and the annual model (TRACE) published by the University of Toronto. These two models were selected since they represent the published versions of two intensive ongoing research and development programs in the area of large-scale econometric models in this country. Furthermore, both models have been used for policy analytic purposes, and the TRACE model has been used in serious forecasting exercises.

The direct transmission mechanisms for international wage and price changes in these models are contained within their respective wage and price sectors. Since we are interested in measuring the impact of these changes at given levels of output, employment and final demand, it is meaningful to examine the wage-price sectors in each model in isolation from the rest of the system of equations.

The partial long-run relationships among foreign prices and domestic wages and prices derived from the relevant equation in RDX1 are as follows:

Implicit Deflator for Gross National Expenditure:[14]

$$P_{GNE} = 1.4038\ ULC + .2136\ P_F + .000097\ WQ + .154$$

[14] These three equations are based on the long-run relationships implied by equations (56), (58), and (85) respectively, reported in *The Dynamics of RDX1*, by John F. Helliwell *et al.* Ottawa, Bank of Canada, 1969. (Bank of Canada. Staff Research Studies No. 5). Paralleling our own calculations, we ignored the effects of international price changes upon profits in the wage equation. The seasonal dummy and inventory disequilibrium and other demand variables are suppressed.

Implicit Deflator for Consumer Expenditure on Nondurable Goods:

$$P_{ND} = 0.6037\ ULC + .275\ P_F + .000099\ WQ + .357$$

Wage Rates in Private Sector:

$$\dot{W} = .938\ \dot{P}_{ND},$$

where P_F is the implicit deflator for imports, ULC is unit labor costs, and WQ is the quarterly wage.

Note the peculiarity that in RDX1 the price index of consumer nondurable goods rather than the price index for all consumer products is the key variable in the wage equation, and that the key wage-price linkage involves this price index.

The long-run elasticities for the price equations are unfortunately not published with the model. However, approximate elasticities may be derived from the published equations.[15]

We therefore derive the following approximate partial relationships among rates of change in the wage and price variables:

$$\dot{P}_{GNE} = .214\ \dot{P}_F + .633\ \dot{W}$$
$$\dot{P}_{ND} = .275\ \dot{P}_F + .368\ \dot{W}$$
$$\dot{W} = .938\ \dot{P}_{ND}.$$

This simple three equation system is readily solved to obtain the long-run impact of foreign prices on domestic wages and prices shown in Table IL below.

The partial long-run relationship between foreign prices and domestic prices and wages derived from relevant equations in the TRACE model are as follows:[16]

Price Index for Business Non-Farm Output:

$$\dot{P}_Q = .681\ \dot{W} + .432\ \dot{P}_F$$

Price Indexes for Components of Consumer Expenditure:

Durables

$$\dot{P}_D = 1.096\ \dot{P}_{GNE}$$

Nondurables

$$\dot{P}_{ND} = .836\ \dot{P}_{GNE} + .338\ \dot{P}_F$$

Services

$$\dot{P}_S = .488\ \dot{P}_{GNE}$$

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[15] These approximate elasticities are evaluated for the base year of the implicit deflators, 1957. The elasticity of the two domestic price indexes on the implicit deflator for imports are simply the corresponding coefficients. The derivation of the elasticity for wages is as follows. Let the equation determining a price index be: $P = a + bW + cP_F$. The elasticity of P with respect to changes in W is defined as follows: $\varepsilon = \frac{\partial P}{\partial W}\frac{W}{P} = \frac{b}{P}\left(\frac{P-a-cP_F}{b}\right) = \frac{P-a-cP_F}{P}$.

If P and $P_F = 1$, as is the case for the base year, then $\varepsilon = 1-a-c$.

In the elasticity calculations we assume that a one per cent increase in wages has proportionate effects on unit labor costs and on the quarterly wage rate.

[16] These relationships are partial long-run relationships derived from equations G.5, G.9, G.10, G.11 and G.1 respectively. See Choudhry *et al.* (1972), pp. 61–62.

Wage Rates in Private Sector

$$\dot{W} = .309\ \dot{P}_C,$$

where $\dot{P}_C$ is the percentage change in the implicit deflator for total consumer expenditures.

Note that in TRACE each consumer expenditure price deflator is linked to an aggregate deflator which in turn is linked, via identities and exogenous components, to the price index for non-farm private output. If we assume that the deflator for GNE and the deflator for private non-farm output move closely together, and make use of the identity linking $\dot{P}_C$ with $\dot{P}_D$, $\dot{P}_{ND}$ and $\dot{P}_S$,[17] we may reduce the above system of equations to:

$$\dot{P}_{GNE} = .681\ \dot{W} + .432\ \dot{P}_F,$$
$$\dot{W} = .309\ \dot{P}_C, \text{ and}$$
$$\dot{P}_C = .729\ \dot{P}_{GNE} + .170\ \dot{P}_F.$$

This equation system is readily solved for $\dot{P}_{GNE}$, $\dot{P}_C$ and $\dot{W}$ in terms of $\dot{P}_F$.

Before examining the properties of the solutions of these equations for the two models, we should note that in neither RDX1 nor TRACE does the wage equation include direct effects of U.S. wages. Hence the immediate transmission of international influences is solely via prices. Furthermore, in both models, prices are implicitly fully adjusted for the exchange rate, since the foreign prices used are implicit deflators based on ratios of domestic values to constant dollar magnitudes. Hence both models will have the property that appropriate exchange adjustments will fully and quickly insulate the Canadian economy from inflationary pressures from abroad.

The solution values for these two models under conditions of inflexible exchange rates and steady state rates of inflation of one per cent abroad are shown in Table IL below.

TABLE IL

Implied Wage and Price Effects of 1% Increase in Foreign Prices Shown in Two Large-Scale Econometric Models

Variable	RDX1 Model	TRACE Model
Implicit Deflator ($\dot{P}_{GNE}$) for GNE	0.46	0.55
Implicit Deflator ($\dot{P}_C$)* for Consumer Purchases	0.42	0.57
Wage Rates ($\dot{W}$)	0.39	0.18

*Implicit deflator for Consumer Nondurables (P_{ND}) is used in model RDX1.

Both models show a substantial impact of inflation abroad upon both consumer prices and the GNE deflator in Canada at given levels of aggregate demand.

[17] Weighting the coefficients of each of these components of consumer expenditure by their relevant importance in 1961 yields the equation for $\dot{P}_C$ shown below.

However, the implied wage effects are quite different: In RDXl the wage effects are moderately strong, whereas in TRACE they are quite weak. This reflects the much larger impact of the consumer prices on wages in the RDX1 model.

These results cannot, of course, be compared directly to our own, since the wage and price indexes are much more aggregative. Since one would presume that manufacturing wages and prices would be somewhat more sensitive to foreign influences than most other prices and wages in the economy, the price results of both models and the wage results of RDX1 would not appear to conflict greatly with our own conclusions under an inflexible exchange rate.

The weak international influence on wages shown by this version of the TRACE model may be attributable to the very weak effect of consumer prices in the wage equation. In view of the growing body of evidence suggesting that the effects of consumer prices on wages in this country is very large, we feel that this result understates the long-run impact on wages in Canada of inflation abroad.

In contrast to the equations of these two large-scale econometric models, the price and wage equations developed by Bodkin *et al.* involve direct wage influences as well as direct price influences from the U.S. Solution values for rates of change of domestic wages and prices in terms of foreign wages and prices are presented in their study. The solutions based on their preferred wage and price equations are as follows:[18]

$$\dot{P}_C = .539\ \dot{W}us + 1.038\ \dot{F}$$
$$\dot{W} = .496\ \dot{W}us + .453\ \dot{F}.$$

These equations indicate that if foreign prices and U.S. wages both rise one per cent, domestic wages will rise by 0.95 per cent and domestic prices by 1.57 per cent in the long run.

These equations therefore imply long-run effects which are substantially greater than the largest of the effects derived above from our equations, and much larger, needless to add, than the effects derived from the RDX1 and TRACE models.

We feel, however, that these results involve considerable overstatement of the effects of inflation abroad for the following reasons:

1. The specification of the price equation creates the problem of a spurious relationship between the current change in the price index and its lagged value. Since this variable is specified as the four-quarter overlapping change, three-quarters of price change are necessarily common to $\dot{P}_t$ and $\dot{P}_{t-1}$. This will result in a serious upward bias to the coefficient to $\dot{P}_{t-1}$,[19] which in turn probably imparts an upward bias to all the long-run effects.

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[18] See Bodkin *et al.* (1966) p. 171. These are the solution values based on equations (5.1e) and (5.36e.)

[19] In econometric terms, the application of a four-quarter moving average will introduce a strong positive serial correlation into the error term of the transformed equation. This will impart an upward bias to the coefficient on the lagged dependent variable.

This will therefore magnify the estimate of the long-run influence of international prices.

2. The omission of purchased input prices from the price equation determining consumer prices probably involves some overstatement of the effects of foreign prices. In the absence of purchased input prices, foreign prices may act as a proxy for their effects.
3. The absence of allowance for the effects of excess demand in the price equation will probably give rise to upward biases in the foreign price coefficients, since aggregate demands in the two countries are correlated.

In the light of these problems we conclude that the estimates based on the equations of Bodkin *et al.* probably involve a considerable overstatement of the direct effects of international wages and prices, which explains why their results cannot be reconciled with our own or with the results derived from the two aggregate models.

SUMMARY

On the basis of these comparisons, we feel that the calculations based on our equations provide a reasonable illustration of the impact of foreign prices and of foreign wages upon inflation in the manufacturing sector of our economy. We must add one final word of caution, however. Throughout our calculations we have assumed that the effects of foreign inflation upon demand are neutralized. If, as is likely to be the case, this does not occur, the inflationary pressures generated will likely be much stronger. Indeed, given the strong relative price sensitivities of Canadian imports and exports, and the possibility that the money supply may itself be partly endogenous and respond to interest rates abroad, we should not be surprised if the *total* impact of inflation abroad is considerably greater than these calculations indicate. An examination of the impact of inflation abroad through these channels using one of the large-scale econometric models would be an illuminating exercise.

chapter nine

INTERNATIONAL COMPARISONS

To this point we have considered the importance of the international transmission of wage and price changes. While this has provided one reason for the study of wage and price determination in the U.S., perhaps as important is the identification of significant similarities and significant differences in the behavior of wages and prices in the two countries. An understanding of these will enable Canadians better to judge when successful policies adopted in the U.S. should be emulated and when they should be avoided. Our discussion must necessarily be qualitative rather than quantitative, since the coverage and comparability of the equations estimated for the two countries at the industry level is very different.

WAGE BEHAVIOR

In the case of the wage equations, one striking difference in behavior is readily apparent. This involves the response of wages to changes in consumer prices (CPI). Models which focus on the consumer price effects in expectational terms yield vastly different results for the two countries. In Canada the price coefficients are typically close to unity and hence are in general agreement with the expectational hypothesis of Friedman (1968). By contrast, the price coefficients in the U.S. are substantially lower (about 0.4), being statistically significantly less than unity. In this respect our results at the industry level are in general agreement with the manufacturing results obtained by Turnovsky (1972)

and Turnovsky and Wachter (1972) who studied the impact of price expectations on wage behavior in the two countries, as well as with the results of other aggregate studies.[1]

Because of the unavailability of direct expectations data on a quarterly basis we have not explicitly formulated our models from the point of view of an expectations theory. However, our specifications and results provide some indirect supporting evidence. It will be recalled that for the Canadian equations, current negotiated wage changes were assumed to be a function of current explanatory variables including current price changes. Furthermore, in a previous study by Turnovsky (1970), it was found that over the period 1962-69, expectations moved very closely with current price changes, suggesting that current price changes may in fact serve, perhaps only crudely, as proxies for expectations.[2] If this is so, one may interpret the importance of the CPI in the Canadian equations as being substantially due to an expectations effect. Thus the finding that many of the industry price coefficients are close to unity is in general consistent with the aggregate phenomenon.

On the other hand, the results at the industry level in the U.S. using this same simple proxy expectational model were so weak that we decided to use an entirely different specification which takes into account the important institutional characteristic of escalator clauses in union contracts.[3] For U.S. workers who do not have escalator protection we assume that the adjustment to consumer prices takes the form of front end contract loading to adjust for rates of price inflation occuring over the preceding contract. The fact that these formulations work much better than the simple expectational formulation at the industry level explains in part why the coefficient on prices in the expectational models are so low in the U.S. Under conditions of misspecification of the form of the independent variable, substantial errors of measurement are introduced which may bias the partial regression coefficients towards zero.

It is difficult to understand why wage bargains in Canada are so strongly influenced by current consumer price developments (and thus probably by price expectations), whereas, in the U.S., the non-escalator based wage response to price changes is essentially backward looking. The strong correlation between consumer price indexes of Canada and the U.S., together with the Turnovsky-Wachter finding that U.S. price expectations appear to be a more important determinant of wage changes in Canada than in the U.S. perhaps provides a clue.[4] In an open economy, forward looking behavior with respect to inter-

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[1] See for example, Gordon (1970, 1971), and Helliwell *et al.* (1969).

[2] Actually in the best equation the immediate past trend in price changes was also quite an important explanatory variable. However, we feel that by the time our contact weights are applied to that variable, it would not add much to the contract-weighted current price changes themselves. Moreover, if we had assumed some kind of distributed lag on prices as capturing expectational effects the application of contract weights, and the smoothing of the data they involve, would introduce severe multi-collinearity.

[3] In contrast to Canada, where contracts with price escalators account for less than 20 per cent of the employees covered by major collective bargaining arrangements, in the U.S. almost 40 per cent of employees were so covered in the late 1960s.

[4] The simple correlation between price changes is about 0.9, when contract-weighted variables are used.

national price developments may be important, and with no variable to measure this factor explicitly, the current change in the consumer price index may act as a proxy. We put forward this explanation only tentatively, however, since research on the effects of expectations of price changes abroad at the industry level has not been carried out.

Nevertheless, these findings are also consistent with the Turnovsky and Turnovsky-Wachter aggregate results. One further question investigated in these studies was the extent to which *deviations* between actual and expected price changes, which in effect adjust for prediction errors committed in the past, are also important determinants of wage changes. The conclusion they reached was that while this "catching-up" phenomenon was clearly important in both countries, it was much more important in the U.S. and in fact in that case dominated the expectations effect itself. This is precisely the conclusion reached in the present set of U.S. equations.

A less important difference in wage determination between the two countries involves the labor market demand variables. In Canada, the unemployment rate *per se* does not appear to play an important role in the bargaining process, whereas it is sometimes important at the industry level in the U.S. Moreover, in the aggregrate equation for U.S. manufacturing, the unemployment effect is of the expected direction and has a significant long-run impact on the rate of wage inflation.

In Canada, by contrast, the unemployment rate only appears to affect wage drift;[5] negotiated rates are not influenced by this variable. At the industry level, labor market demand conditions have a positive impact on negotiated rates in nine of 15 industries but in seven of these cases it is the percentage change in production worker employment that is the relevant variable. These results are also borne out in the aggregate results for Canadian manufacturing.

Several reasons may be adduced for these differences in results. Variations in the labor force have recently had a major impact on unemployment rates in Canada. An increase in unemployment brought about by an increased rate of growth of the labor force can hardly be expected to have the same short-run effect on wage negotiations as the same amount of unemployment generated by laying off experienced workers (particularly union workers).

The role of actual or potential international competition is obviously of greater importance for the typical Canadian manufacturing industry than for its U.S. counterpart. Consequently, the potential competition of foreign labor abroad may loom larger in the eyes of the union than the potential competition of unemployed workers at home. In an open economy, revealed changes in the demand for the particular labor supply controlled or partly controlled by the union—as shown by employment changes in the industry—may consequently have a greater effect than existing aggregate surpluses or shortages of workers.

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[5]This is apparent in Table XVI of Chapter 3. Note that, with the exception of the leather and miscellaneous industries, only the deviation between the current value of the recipient of unemployment and its contrast weighted counterpart is important.

Finally, the extent of unionization is somewhat greater and the degree of industrial concentration much higher in the typical manufacturing industry in Canada. As a result, wage behavior in Canada might be expected to approximate more closely the pure bilateral bargaining model developed above in chapter two than would wage behavior in the U.S. Recall that in that model employment change rather than the level of unemployment is the relevant labor market demand variable.

The final remaining difference involves the impact of foreign wages on domestic wages. Unlike the differences discussed above, however, this is a difference in the specification of the models used rather than in the empirical results obtained. No U.S. wage equations were estimated with foreign wage changes as an independent variable.

Three strong similarities of behavior may also be noted. First, in both countries, the use of the contract based distributed lag weighting scheme yields improvements in statistical fit, thereby indicating that this element of institutional reality—attributable to the existence of trade unions—is important. Second, at the industry level it is important to make allowance for inter-industry linkages in both countires.

Finally, the profit rate plays an important role in both countries, thereby providing additional support for the theoretical and empirical results of previous writers.[6] In both countries, therefore, variations in product market demand conditions may be expected to have effects on wage behavior, and policy measures which affect rates of return may be anticipated to have repercussions on wage rates as well.

PRODUCTIVITY RESULTS

We turn now to a comparison of the productivity results obtained for the two countries. It would obviously be extremely tedious and of little value to give a complete industry-by-industry comparison for all the manhour components we have estimated. Instead, we restrict our comments to two aspects of the results. First we give a complete comparison for all manufacturing. Secondly we compare the productivity trends calculated for total manhours for the different major group industries. However, although we do not give a complete discussion, we can say that the two sets of results are remarkably consistent for the two countries and this is particularly true for all manufacturing.

In Table L we list the short-run elasticities, the intermediate-run elasticities, and the productivity increases for the various components of manhours for both Canada and the U.S.[7] Note that since no U.S. equation was estimated for for M_6, total worker standard hours, our comparison is restricted to the first five groups. We should also point out that the Canadian equations were esti-

[6] See Levinson (1960), Eckstein-Wilson (1962), Eckstein (1964).

[7] It should be recalled that the short run refers to one quarter and the intermediate run to four quarters. The long-run elasticity by assumption is unity.

mated using the logarithmic formulation whereas in the U.S. the linear version was used. As a result the calculated Canadian elasticities are constant over the sample period, while the U.S. elasticities vary with time, those reported being given at the first quarter of 1960, the mid-point of the period.[8]

Looking first at the short-run employment elasticities, the estimates for the different components are amazingly close. The elasticity of production worker straight time hours is 0.56 for Canada and 0.55 for the U.S. and the aggregate figures are 0.67 and 0.60 respectively. This minor difference is due to the fact that in the short run, overtime labor is slightly more elastic in Canada than in the U.S. (3.58 as compared to 3.18).

This consistency carries over to the intermediate-run elasticities where virtually identical estimates are obtained for production worker overtime hours and non-production worker hours respectively. The total intermediate-run elasticity in Canada is 0.94 and is slightly higher than the corresponding figure of 0.85 for the U.S. The difference is mainly due to the fact that over the longer period there is more response in the use of production workers in Canada than there is in the U.S.

To summarize the first four columns of Table L we can say that overall, both in the short run and in the intermediate run, employment in Canada is slightly more elastic than it is in the U.S. In the short run the difference arises from the difference in production worker overtime elasticities; over the intermediate period, it is due to the higher elasticity of straight-time production worker employment.

From the last two columns we see that the overall increases in labor productivity in the two countries are virtually identical (3.33 and 3.31). Moreover, the pattern among the different labor groups is very similar; in both countries overtime labor shows high increases and non-production workers increases well below the average. In both these categories productivity in Canada has been increasing relative to that in the U.S. However this is offset by a larger increase in the productivity of U.S. production worker straight-time hours relative to that in Canada.

In Table LI we report the productivity trends for total manhours for the 14 major group industries in the two countries.[9] The patterns provided by these figures are also very similar in both cases. If we adopt the convention introduced in chapter four of dividing industries into high, medium and low productivity groups according to whether their trend increase is more than 0.5 per cent greater than, plus or minus 0.5 per cent of, or more than 0.5 per cent less than, the overall manufacturing productivity increase respectively, we find the results to be in general agreement. Thus according to this criterion textiles, petroleum and coal, and chemicals fall in the high category in both countries. Tobacco,

[8]For a discussion of these two functional forms see chapter two, section three, chapter four and chapter six. We should point out that although the logarithmic form was selected for Canada, we did estimate the linear form as well. The elasticities calculated at the mid-point of the sample period were virtually identical to those reported above.

[9] It should be recalled that the U.S. equations were estimated for 19 two-digit industries. Thus where necessary the estimates obtained for the U.S. industries were averaged to yield estimates on a comparable basis to these obtained for Canada. Since there is no industry in the U.S. comparable to Canadian miscellaneous, this industry is excluded from the comparison.

also in the high group in Canada, drops to the upper range of the medium U.S. group. At the other end of the scale food and beverages, leather, paper, printing and publishing, and non-metallic minerals show low productivity increases in the two countries. Apparel and wood which are in the low group in Canada are in the medium range in the U.S., but on the other hand metals which is in the medium group in Canada, shows low productivity increases in the U.S. The overall agreement of the pattern of the industry productivity increases is summarized in the simple correlation coefficient of the productivity trends, which is 0.72.

But there are some differences and it is useful to identify those industries where Canada has been making relative productivity gains and losses. If we regard a difference in productivity trends of 0.5 as indicating a relative improvement or deterioration in productivity as the case may be, we see the following. Canada has had productivity increases relative to the U.S. in five industries—tobacco, leather, textiles, printing and publishing, and the important metals group. On the other hand, it has had lower productivity gains in apparel, wood, and transportation equipment. The remaining industries show roughly equal productivity improvements in the two countries.

PRICE BEHAVIOR

The general models of price determination estimated at the industry level for the two countries differ in two respects. First, allowance is made for direct effects of U.S. prices on the prices of corresponding industries in Canada, whereas in the U.S., international price changes only enter the system through their effects on purchased input prices and on excess demand. Second, in the U.S. allowance is made for the effects of internal funds requirements and interest rates. In Canada, data were not available on the funds variable, and the interest rate was only included in the aggregate equation.

Otherwise, the general models may be described as flexible target margin pricing models, the element of flexibility coming from (a) the sensitivity of these prices to excess or deficient demand conditions, and (b) the adjustment process whereby prices respond to changes in costs with a distributed lag. The models therefore imply that in the long run prices are set to attain a target margin over unit costs (with the target margin in the Canadian case depending on U.S. prices), whereas in the short run prices changes are influenced by both excess demand and the lagged adjustment of prices to deviations between target and actual margins.

Leaving aside the influence of U.S. prices on Canadian prices, and the capital cost and capital requirements variables, it is noteworthy that the remaining variables—excess demand, normal unit labor costs, and purchased input prices—play important roles in both countries.

The results for the price equations for all manufacturing in the two countries are very comparable (see Table LII). Excess demand enters both equations,

although it is measured by different variables (inventory and unfilled orders disequilibria are both significant in Canada, whereas the ratio of new orders to sales is significant in the United States). The response of prices to changes in unit labor costs is very similar. In the short run, changes in these costs are largely absorbed in reduced profit margins, in the long run they are shifted forward by about the same amount in both countries.

Purchased input or materials prices are also important in both equations at the manufacturing level. However, while the short-run coefficients are very similar, the long-run response in the U.S. is considerably larger than in Canada, although in the latter case, the Canadian coefficients may be affected by the presence of international prices in the Canadian price equation.

Finally, the significance of interest rates and internal cash requirements in the U.S. is paralleled by the significance of interest rates and tax rates in Canada.[10]

Turning to the industry equations as a group, we again note a number of similarities. Both the cost variables and the demand variables are at least marginally important in most of the industries examined. The aggregation of the short and long-run responses to changes in labor costs yields results which are very close and which confirm the results of the equations for the manufacturing sector. The short-run price elasticities in response to input price changes are comparable, but the long-run impact of material prices is much larger in the U.S., again perhaps reflecting the importance of international prices in the Canadian situation. However, it is worth recalling that there is a tendency to obtain very high input price elasticities in a number of industries in the U.S., which may reflect certain data limitations.[11]

On balance, however, the price equations estimated for Canada at the industry level are both more comprehensive and more satisfactory from a statistical standpoint than the comparable price equations for the U.S. This probably reflects two factors. First, the basic price data for Canadian manufacturing are industry selling price indexes which can be readily aggregated to larger industry groupings. In contrast, the basic U.S. price data are indexes constructed on a commodity basis rather than an industrial basis, and industry price indexes constructed from such data are probably less accurate than the Canadian selling price series. Second, we have found that international prices play a key role at the manufacturing level and in a number of industries in Canada, thereby adding to the explanatory power of the price equations for these industries.

Taking these comparisons as a whole, the most significant differences between wage and price behavior in the two countries appear largely attributable to the openness of the Canadian economy in relation to the U.S. Otherwise, with some exceptions, the results obtained for both countries are sufficiently comparable and sufficiently consistent with the theoretical models developed in chapter two to provide strong empirical support for the models used.

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[10] Note that we refer here to the supplementary tests presented at the end of chapter five.

[11] As a result of this problem, U.S. price equations were estimated subject to constraints on the cost variables in four cases.

TABLE L

Comparison of Canadian and U.S. Manhour Elasticities and Productivity Trends for All Manufacturing

Type of Labor	Short-run elasticity of employment with respect to output		Intermediate-run elasticity of employment with respect to output		Trend rate of productivity increase, at annual rates	
	Canada	U.S.	Canada	U.S.	Canada	U.S.
M_1 Prod. worker total hours	0.79	0.76	1.09	1.03	3.65	3.94
M_2 Prod. worker straight time hours	0.56	0.55	1.01	0.90	3.38	3.90
M_3 Prod. worker overtime hours	3.58	3.18	2.21	2.26	5.78	5.04
M_4 Non-production worker hours	0	0	0.31	0.30	2.36	1.42
M_5 Total worker hours	0.67	0.60	0.94	0.85	3.31	3.33

TABLE LI

Comparison of Canadian & U.S. Productivity Trends for Total Manhours*

	Canada	U.S. **
All Manufacturing	3.31	3.33
Food & Beverages	2.51	2.82
Tobacco	5.32	3.74
Rubber	3.09	3.23
Leather	2.72	1.83
Textiles	5.24	4.00
Apparel	2.14	2.33
Wood	2.39	3.40
Paper	2.07	2.49
Printing & Publishing	2.44	1.73
Metals	3.18	2.19
Transportation Equipment	2.90	3.65
Non-metallic Minerals	2.16	2.38
Petroleum & Coal	4.12	4.43
Chemicals	5.16	5.15

* All quantities are at annual rates.

** U.S. growth trends are calculated in the mean of the period.

Table LII

Canada—U.S. Comparisons: Elasticities of Prices with Respect to Changes in Unit Costs

		Canada	U.S.
A. Based on Equation For All Manufacturing			
Unit Labor Costs	Short Run	0.10	0
	Long Run	0.43	0.48
Input Prices	Short Run	0.19	0.17
	Long Run	0.16	0.29
B. Based on Aggregating Industry Equations			
Unit Labor Costs	Short Run	0.10	0.12
	Long Run	0.32	0.33
Input Prices	Short Run	0.23	0.19
	Long Run	0.29	0.53

chapter ten

CONCLUSIONS AND POLICY IMPLICATIONS

We conclude this study by considering the implications of our extensive econometric results for certain policy issues to which we feel they are of some relevance.

The first issue is related to recent theoretical developments in the literature dealing with the existence and stability of Phillips type trade-off curves. Related to this is the question of the existence of a unique "natural" rate of unemployment consistent with wage stability or steady rates of wage inflation in the event that the Phillips curve does not exist.

In both Canada and the U.S., wage behavior in the short run is in general sensitive to demand conditions in their respective labor markets. As a result there is a *short-run* trade-off between reductions in unemployment and increased rates of wage inflation.[1] However, given that wage increases appear to be largely absorbed in the short run, the *short-run* trade-off between reductions in unemployment and increased rates of price inflation will be substantially lower.

However, since consumer price changes enter the wage equations for both countries, the short-run relationships between the rates of inflation and unem-

[1] The slope of the short-run trade-off curve between wage changes and unemployment is given by $(a_1 + k_{tt}a_2)$ where a_1, a_2 are the coefficients of U_t^{-1} and $(U_t^{-1})^*$ in the wage equation and k_{tt} is the percentage of production workers at time t under contracts negotiated at that time. It will be recalled that for all manufacturing in Canada we obtained $a_1 < 0$, $a_2 > 0$ with $a_1 + a_2 < 0$, implying a perverse long-run relationship. However, since k_{tt} is typically around 0.10, the estimated magnitudes of a_1 and a_2 are such that $(a_1 + k_{tt}a_2) > 0$, implying a negative short-run trade-off. Similarly, the employment change models imply a positive short-run trade-off between the rate of wage inflation and the rate of change of employment.

ployment levels will almost certainly shift over time. Therefore we consider whether or not a stable equilibrium exists between these variables towards which the system would converge if the unemployment rate were maintained at a given level.

Our wage equations indicate that the answer to this question is different for the two countries. In line with the conclusions of a growing number of empirical studies, we conclude that a partial long-run trade-off does exist between unemployment and rates of wage increase in the U.S. We emphasize the world partial, because other variables—particularly profits—also play an important role. Because of the relatively weak effect of consumer prices on wages in the U.S., this trade-off is relatively stable in the sense that the long-run trade-off exists and is not that different from the immediate trade-off.

The situation in the long run for Canadian manufacturing is quite different. At the all manufacturing level, there is some evidence of perverse effects of unemployment upon negotiated wage changes. This may reflect aggregation difficulties, however, since at the industry level the important labor market variable is typically employment change for the industry. Where unemployment does affect earnings at the industry level, its influence is confined to wage drift and it does not affect negotiated rates.

In contrast to the situation in the U.S., consumer price changes have a substantial impact on wages changes in Canada. These two results imply the absence of a stable trade-off between rates of wage increase and rates of unemployment within the Canadian manufacturing sector. Moreover, they also imply that the rate of inflation within manufacturing may be independent of the level of unemployment *per se*, and hence that there is also no unique "natural" rate of unemployment which is consistent with stable rates of inflation.

We next turn to the important question of the relative importance of direct international influences. While most observers believe that international price developments have an important impact upon inflation within Canada, it is important to identify the various channels through which they may operate. In particular there may be:

(a) aggregate demand effects working through the effects of changes in prices upon demand for Canadian exports;
(b) induced monetary effects resulting from changes in the balance of payments under a fixed exchange rate;
(c) cost-push effects working through the increase in the price of imports;
(d) direct influences upon prices set by Canadian firms, and
(e) direct influences upon Canadian wage negotiations.

The present study presents evidence bearing on the extent to which international influences are felt via the last three channels. The magnitudes of such direct effects are important, since they imply a rapid response to international price and wage developments and since their impact upon domestic prices cannot be neutralized by domestic macroeconomic policy adjustments when the ex-

change rate is fixed, without reduction in employment occurring as a result. Hence the importance of the direct effects provides an indication of the extent to which inflation is outside our control under a fixed exchange regime, and serves to highlight the possible advantages of adopting a flexible exchange rate system as an alternative.

Both the set of wage and the set of price equations imply that such direct international influences are important. The set of price equations imply that the immediate effect of a one per cent change in U.S. prices is to increase Canadian prices by at least two tenths of one per cent. The aggregate wage equation implies that a one per cent increase in U.S. wages will yield an immediate increase in Canadian wages of at least four tenths of one per cent. It is interesting to point out that this latter estimate is remarkably consistent with that obtained by summing the international effects of the two-digit industries using employment weights.

If account is taken of the interaction between prices and wages in Canada, and if allowance is made for the effect of changes in international prices upon materials costs to the Canadian manufacturing sector, the long-run impact of changes in international prices is of course significantly increased. As demonstrated in chapter eight, when these effects are taken into account, a one per cent increase in prices and wages abroad will increase rates of wage and price inflation in Canadian manufacturing by about three quarters of one per cent.

These results, therefore, clearly indicate not only that inflation abroad is an important cause of inflation in Canada, at least under fixed exchange rates, but that inflation abroad impinges directly on price making and also wage negotiations in Canada. As a result, reductions in employment may be required to completely offset these external inflationary impulses, if it is desired to stop the inflation.

The third question we wish to discuss is the celebrated one of lags in response to changes in macroeconomic policies. The set of equations we present are consistent with the view that the lags in the response of prices and wages to changes in aggregate demand are considerably longer than the lags in the response of real output. While the time pattern of these responses can only be determined through simulation analyses involving the system of equations we have developed and a macroeconomic model of the economy, the reasons why the wage-price response is delayed and prolonged relative to the output response can be simply stated.

1. The productivity functions imply that employment responds sluggishly to changes in output. This means that labor market demand conditions—important determinants of changes in wage rates—lag behind changes in output.
2. The wage response to all of the determinants of wage changes except those influencing wage drift is prolonged because of the existence of contracts extending across several quarters. Hence it takes about three years for the effects of the change in one of the determinants of negotiated wages to be fully felt in observed earnings.

3. While the response of prices to international prices, excess demand and raw materials prices is reasonably quick, the response of price changes to wage changes is characterized by a fairly long distributed lag.

As a result of these three key lags, the response of prices and wages to changes in demand will be more sluggish and more prolonged than the response of real output.

We now turn to the issue which is of perhaps overriding importance at the present time, namely, the implications of our results for a policy of wage and price guidelines. Before proceeding with this discussion we should emphasize that we are not commenting upon the desirability of such a policy at the present time, nor shall we discuss the means by which it could be implemented and made effective.

First, what do our results indicate as to the basic feasibility of a policy of wage and price guidelines? As noted in chapter one, a necessary condition for such a policy to be effective is that price makers and/or wage bargainers must have some discretionary influence over prices and/or wages, at least in the short run. If prices and wages were purely market determined, a guidelines policy would be useless. Our results are consistent with the view that, while both prices and wages are influenced by excess demand conditions in the relevant markets, elements of discretionary market power nevertheless exist. The direct influence of U.S. prices upon Canadian prices, the tentative evidence on the effects of taxes and interest rates on prices, and the evidence in the U.S. that capital requirements influence prices are all consistent with the view that within the limits set by conditions of entry, firms possess some discretionary power over prices. The importance of profits in wage determination in both countries, and the direct influence of U.S. wages upon Canadian wages is similarly consistent with the view that collective bargaining can yield wage rates which differ from those that would be determined by market forces alone. The fact that the distribution of contracts should be taken into account in explaining the determination of wages also indicates that collective bargaining has an important influence upon the timing of changes in wages.

Hence we view our results as indicating that wages and prices are determined by a mixture of traditional market forces and variables which reflect the market power and relative bargaining positions of firms and trade unions. Accordingly we view these results as indicating that a guidelines policy is feasible.

The results also have interesting implications for the relative effectiveness of wage and price guidelines. Since the wage equations indicate that wages respond strongly both to consumer prices and to corporation profits, a policy which succeeds in limiting prices and profits could have reasonably immediate effects on current wage negotiations although their eventual impact upon earnings is delayed because of the contract lag. In contrast, the short-run effects of changes in earnings upon prices is quite weak (and the short-run effects of change in negotiated rates is even weaker because of contract lags). Hence a policy of effective price guidelines unaccompanied by wage guidelines could have quick

effects upon wages as well as prices, whereas a policy of effective wage guidelines unaccompanied by price guidelines would not have an immediate effect upon prices. Since timing is of the essence in any policy to control inflation, and since the difficulty of maintaining voluntary compliance would increase greatly if the policy were not quickly and visibly effective, it follows that the effective implementation of price guidelines should be the cornerstone of any overall guidelines policy.

While the results therefore suggest that a guidelines policy may be basically feasible, they also indicate that a policy of rigid guidelines and in particular of formal direct controls on wages and prices is also potentially dangerous. Prices and wages are both sensitive to variations in demand and supply conditions over time. This indicates that relative price changes and relative wage changes are serving to some extent an important resource allocation function. Any system of controls or guidelines which blunts this important function will involve obvious costs.

The strength of international linkages in both the price and wage equations and the strong role of consumer prices in wage determination suggests that there are other avenues by which the dilemma of inflation at moderately high levels of unemployment may be resolved.

At a minimum, the adoption of a freely floating exchange rate would permit Canada to insulate its economy from inflationary pressure from abroad to some extent. However, more deliberate policies may also be useful. Such policies could include tariff reductions or a deliberate appreciation of the exchange rate through appropriate combinations of monetary and fiscal policies. Both policies could be used to reduce inflationary pressures at given levels of aggregate demand.

Finally, tax policies designed to reduce the inflation of consumer prices at given levels of aggregate demand should be given active consideration. As has been demonstrated in a recent policy paper,[2] reductions in sales taxes may be expected to have substantial deflationary effects on consumer prices at given levels of real demand, and our results at the industry level provide additional empirical justification for the analysis presented in that paper. The nature of the wage-price mechanism in this country suggests that once and for all reductions in sales taxes could perhaps yield lasting benefits in terms of lower rates of inflation at given levels of aggregate demand.

Given that wage and price changes do appear to be serving—at least in terms of the direction of movement—an appropriate resource allocation function, a guidelines policy which is supplemented by policies designed to improve the operations of markets has much to recommend it over any system of controls designed to replace the functioning of such markets. For example, a policy of selective tariff reductions could be used very effectively in conjunction with a guidelines policy, and price guidelines in turn may be a useful adjunct to a policy of sales tax reductions.

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[2] Jump and Wilson (1971).

The final issue to be discussed has to do with the possible effects of direct taxation upon wages and prices. Our tentative results for the manufacturing sector suggest that increases in the burden of direct taxation upon labor income may increase upward wage pressures. If this result is borne out by additional research, it would suggest that there are definite advantages to a policy of government expenditure restraint relative to a policy of tax increases as a means of reducing aggregate demand to fight inflation.

The possible effects of changes in corporate taxes are more difficult to assess. Again the preliminary evidence suggests that corporate taxes are partly shifted forward in higher prices. At the same time, since an increase in taxes also tends to reduce after-tax rates of return, an increase in corporate taxes serves to reduce upward wage pressures through their effects on profits. Further research on this question would appear to be in order.

APPENDIX

This Appendix gives a detailed description of the Canadian data used in the empirical analyses reported in chapters three to five. In particular we describe the data sources and indicate how the basic series were manipulated to achieve the final form of the variables used in the estimation. It should be pointed out that we describe only those data actually used in our empirical work; in fact during the course of the study many other data series were collected. These data are included in a more detailed statistical data bank, which is available from the Prices and Incomes Commission. Furthermore, we do not report the United States data. The relevant variables have been fully described in the text and further details of the underlying data are available from the authors on request.

Since one of the fundamental problems encountered of gathering the data was that of obtaining consistent data series over the period 1949–1969[1] (or as near as possible), we begin with the problem of aggregation and how we have dealt with the changes in the Standard Industrial Classification (S.I.C.) which occurred during the period. This is discussed in section one. The remaining eight sections deal with specific data groupings and are as follows:

Section 2 —Employment and Wage Data—These data are used primarily in the wage and productivity equations. But since unit labor costs appear in the price equation, they occur indirectly there as well.

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[1] Since the study was begun in the middle of 1970 we decided to use all data series up to the end of 1969 throughout our work.

Section 3 —Price Data—This section describes the output and input prices used in the price equation, as well as the Consumer Price Index which enters the wage equation.

Section 4 —Demand Data—These include the inventories, shipments and unfilled orders variables used to measure excess product demand in the price equation.

Section 5 —Financial Data—These include profits and tax data, which were introduced into both wage and price equations.

Section 6 —Output, Capacity and Capacity Utilization Data—These data were used in the productivity functions.

Section 7 —Miscellaneous Data.

Section 8 —Structural Data—These include various inter-industry comparison series, which occasionally were used in assessing the results for the different industries.

Section 9 —Contract Weights—This describes the nature of the distributed lag weights applied to the independent variables of the wage equation.

Finally, since our analysis is quarterly, where appropriate, all series used have been seasonally adjusted using the Bank of Canada's XIII Seasonal Adjustment Package.

THE STANDARD INDUSTRIAL CLASSIFICATION AND AGGREGATION

A major problem in the construction of a consistent data series over the period 1949–1969 arises from the change in the Standard Industrial Classification (S.I.C.) of the two-digit industries. On the basis of the 1948 S.I.C. the manufacturing sector comprised 17 two-digit industries; in 1960 these 17 industries were increased to 20. The problem was compounded by the fact that some component three-digit industries were reclassified so that one could not simply obtain a consistent set of 17 industries based upon the 1948 S.I.C. Moreover, even if this could have been achieved, this would not have been an ideal solution, since present data are collected on the basis of the 1960 S.I.C., so that one could not conveniently continually update the series.

Thus, because of the change in the way in which certain industries were defined, short of aggregating up from the individual three-digit industries, we were forced to create the following 15 industries which are consistently defined for the two S.I.C.'s. These are referred to as "major group industries" or occasionally as the two-digit industries, and form the industry sample for our empirical work. They are of varying size and some idea of their relative importance can be obtained by comparing their employment or shipments expressed as percentages of the total for all manufacturing as is done in section 8.

The industries are defined and related to the 1948 and 1960 S.I.C.'s as follows:

Industries Used in the Present Study		Two-Digit Industries Included: 1948 S.I.C.	1960 S.I.C.
01	Food & Beverages	1	1
02	Tobacco	2	2
03	Rubber	3	3
04	Leather	4	4
05	Textiles	5	5
06	Apparel	6	6, 7
07	Wood & Furniture	7	8, 9
08	Paper & Allied Products	8	10
09	Printing & Publishing	9	11
10	Metals	10. 11, 12	12, 13, 14, 16
11	Transportation Equipment	11	15
14	Non-Metallic Minerals	14	17
15	Petroleum & Coal	15	18
16	Chemicals	16	19
17	Miscellaneous Industries	17	20

However, because of data limitations there are some exceptions to this method of aggregation. In the case of "financial series", some of the major group industries had to be further aggregated giving the following list:

01 Food & Beverages
03 Rubber
07 Wood & Furniture
08 Paper & Allied Products
09 Printing & Publishing
14 Non-Metallic Minerals
15 Petroleum & Coal
16 Chemicals
17 Miscellaneous
30 Tobacco & Miscellaneous
36 Textiles & Apparel
40 Metals & Transport

For the latter three aggregations, the profit series for the groups was used in the wage equation for each of the component industries.

For the capacity series, two aggregations were necessary with "tobacco, leather and rubber" being one aggregation and "non-metallic minerals and petroleum and coal" being another. In these instances, the aggregated series was used for each of the industries which went to make up the aggregation. For example, the "tobacco, rubber and leather" series was used for each of tobacco, leather and rubber.

The data corresponding to these major group industries were aggregated by simple addition in some cases, and by the use of weighting factors in others, depending upon the type of series. Thus, where the data were absolute quantities, such as in employment or the various demand series, direct aggregation is clearly possible. On the other hand, where the series refer to indexes or wage

rates, the aggregation required the component series to be appropriately weighted. The weights used in these cases are indicated below.

The problems caused by the two S.I.C. series was solved by linking the two series together using one of two methods. In all cases there was at least one period overlap where the data were available on both the old and new S.I.C.

The first method, most commonly used, was to construct the following series:

$$\text{“revised Old”} = \text{“Old”} * F$$

According to this method, the final usable series was created by multiplying the "old" series by some adjustment factor F. This adjustment factor was some ratio of the "old" and "new" values during the period of overlap. Normally, it was the ratio of averages of the values for 1962, the first year of overlap. However, where necessary, it was simply the first period overlap ratio.

In a few cases where there was a substantial period of overlap, the series were linked by regression.

If X_N is the "new" series and X_o, the "old" then the regression will yield us

$$X_N = \alpha + \beta X_o$$

an α and a β such that a revised "old" series may be calculated. This method was used only infrequently, as in the case of the financial data series for all manufacturing.

EMPLOYMENT AND WAGE DATA

The basic wage data used are as follows.[2]

(i) *Average Hourly Earnings*

(production workers)

Raw average hourly earnings data for production workers were obtained monthly for the period 1957 to 1969 on a 1960 S.I.C. basis for total manufacturing, as well as the 20 two-digit manufacturing industries from Prices and Incomes Commission tape 637. Similar data on a 1948 S.I.C. basis were obtained for the period 1949 (when available otherwise 1951) to 1965 from the ledgers of the labor division of Statistics Canada for total manufacturing, durable, nondurable and 17 two-digit manufacturing industries.

In accordance with the procedure described in section one, the two-digit data for each of two subsets was aggregated to fifteen major group industries using production worker man hours as weights, in the aggregation. The monthly data were then averaged to quarterly series, again using production worker man hours as weights.

All series were linked by multiplying the ratio of new/old series for 1957 first quarter by the 1948 S.I.C. data for the 1957–1969 period.

[2] These data were assembled by T. Gow.

(ii) *Average Hourly Earnings*

(non-production workers)

Seasonally-adjusted average hourly earnings for non-production (salaried) workers were calculated on a quarterly basis for total manufacturing and the 15 major group industries for the period 1949–1969 (where available, otherwise 1951–1969). For each category, seasonally-adjusted average weekly salaries was divided by 40 which was considered to be representative of average weekly hours for salaried employees. Average weekly salaries is itself a derivative series and the method by which it was constructed is described below.

(iii) *Average Hourly Earnings*

(all employees)

Average hourly earnings for all employees were constructed over the same period as for (ii) above, according to the following procedure. First, for each industry the product of average weekly wages and salaries (see (v) below) and total employment ((ix) below), both seasonally adjusted, was calculated, giving the total wage bill for that industry. Secondly, average weekly hours for production workers ((viii) below) was multiplied by production worker employment ((xi) below) to give total production worker manhours. Thirdly, seasonally-adjusted salaried worker employment ((xii) below), was multiplied by 40 to give an estimate of non-production worker manhours. (As in (ii) 40 is considered to be representative of average weekly hours for salaried employees.) Finally, the second and third items were summed and divided into the total wage bill to give an estimation of the average hourly earnings for all employees.

(iv) *Index Numbers of Average Wage Rates*

(1961 = 100)

In some preliminary work we attempted to construct an index of straight-time average hourly earnings. This approach was eventually abandoned, but in the course of this work we did construct indexes of average wage rates.

Index numbers of average wage rates of production workers (1949 = 100) were obtained for the period 1949–1959 on a 1948 S.I.C. basis for total manufacturing, and 16 two-digit manufacturing industries for the "last normal pay period to October 1st" from the Department of Labour publication, *Wage Rates, Salaries and Hours of Labour.* Additional data, also on a 1948 S.I.C. basis (1949 = 100) for the same industries, but from an expanded survey were obtained from the same source for the period 1959–1965. Similar data, on a 1960 S.I.C. basis (1961 = 100) for the period 1962–1969 for total manufacturing, and 17 two-digit industries were obtained from the same publication.

Following our aggregation procedure and using production worker employment as weights, the two-digit data for each of the first two subsets was reduced

to 15 two-digit groups. The third subset was reduced to 14 groups because no data was available for the non-metallic industry in the 1962–1969 period.

The first two subsets of data were linked using the ratio of new/old for 1959. This derived subset was linked to the third subset using the ratio of new/old for 1962. No linked series was derived for the non-metallic minerals industry.

(v) *Average Weekly Wages and Salaries*

Raw data describing average weekly wages and salaries (for production *plus* non-production workers) were obtained from identical sources and on identical S.I.C. bases as the average hourly earnings series for production workers, described in (i) above. The identical aggregation procedures as described there were applied, with the exception that all-worker employment weights were used in the aggregations.

(vi) *Average Weekly Wages*

Raw average weekly wages for production workers were obtained by multiplying raw average hourly earnings for production workers ((i) above) by raw average weekly hours (see (viii) below). The resulting series were then seasonally adjusted.

(vii) *Average Weekly Salaries*

Seasonally-adjusted average weekly salaries for non-production employees were calculated as follows for the period 1949–1969 (where available, otherwise 1951–1969). For each category seasonally-adjusted salaried employment was divided into the difference between the product of average weekly wages and salaries and total employment reported (both seasonally adjusted) and the product of average hourly earnings, average weekly hours and wage earners (all seasonally adjusted).

(viii) *Average Weekly Hours*

Raw data describing average weekly hours for production workers was obtained from identical sources and on identical S.I.C. bases as the average hourly earnings series for production workers, described in (i) above. The identical aggregation procedures as described there, were applied with production worker employment weights being used in the aggregations.

(ix) *Employees Reported*

Raw employees reported (production plus non-production) data was obtained monthly for the period 1957–1969 on a 1960 S.I.C. basis for total manufacturing, and 20 two-digit manufacturing industries from P.I.C. tape 637. Similar data on the 1948 S.I.C. basis was obtained for the period 1949–1965 from the ledgers of the labor division of Statistics Canada for total manufacturing, durable, nondurable and 20 two-digit manufacturing industries.

In accordance with the procedure described in section one, the two-digit data for each of the two subsets was aggregated to 15 two-digit groups. In this case simple summation was all that was required. The monthly data was converted to quarterly by simple averaging

All series were linked by applying the ratio of new/old for 1957 first quarter to the 1948 S.I.C. data for the 1949–1956 period and using the 1960 S.I.C. data for the 1957–1969 period.

(x) *Employment Indexes*

(1961 = 100)

These data were obtained from identical sources and on identical S.I.C. bases as the data on employees reported, described in (ix). The only difference is that the aggregation required the series to be weighted using total worker employment weights. Also, all series were linked by applying the ratio of new/old for 1961 first quarter as the correction factor in the linking.

(xi) *Wage Earners Reported*

The remarks made in connection with total employees reported, apply identically here.

(xii) *Salaried Employees*

Seasonally-adjusted salaried worker employment was obtained by subtracting seasonally-adjusted wage earners reported ((xi) above) from seasonally-adjusted employment reported ((ix) above).

(xiii) *Unemployment Rate*

Raw monthly data on the aggregate unemployment rate were obtained from *The Labour Force* (DBS 71-001). These data were then averaged to yield quarterly series which were then seasonally adjusted.

PRICE DATA

There were two basic kinds of price data used. First, the Consumer Price Index (CPI) was used as an explanatory variable in the wage equation. This series is readily available from the source indicated below. Secondly, both input and output selling prices were required for the industry and the all manufacturing price equations. These data were not directly available and we therefore constructed indexes of industry output and input prices using the procedures described below. This necessarily involved some arbitrary decisions, and as a result the quality of the final data—particularly for input prices—is perhaps uneven.

Consumer Price Index

Raw monthly data were obtained over the period 1949–1969 from *Prices and Price Indexes* (DBS 62-002). These were seasonally adjusted and aggregated to quarterly series. As indicated in chapter three, the wage equation includes the within-period percentage change in the CPI as one of the explanatory variables. In order to center the variables appropriately, the following procedure was used to calculate these percentage changes.

The data are averages for the month and thus can be regarded as being centered at the middle of the month. In order to obtain prices centered at the end of the month (required to obtain within-period percentage changes) we took successive monthly observations and averaged them. Thus to calculate the within-period percentage change in the CPI we took the price centered at the beginning of the quarter, subtracted it from the price centered at the end of the quarter, and divided by the initial average price. Thus, for example, the percentage change in the CPI for the first quarter was calculated as follows:

$$\frac{\overline{P}_t - \overline{P}_{t-1}}{\overline{P}_{t-1}}$$

The quantity $\overline{P}_t$ is a two-month average of the March and April observations, centered about March 31, while $\overline{P}_{t-1}$ is a two-month average of the December and January observations and thus would be centered about December 31.

Output Prices[3]

For the two-digit industries, output prices were calculated in two segments. For the period 1956–1969, the prices were the industry selling prices of major industry groups provided by Statistics Canada. These were aggregated to the major group industry level by using 1961 shipment weights.

For the period 1949–1956, the data was taken from the General Wholesale Price Index [1935–1939 = 100] which had to be separated into major industry groups by the use of the 1953 commodity classification by industry as given in *Industry Selling Price Indexes, 1956–1959*[4] (pp. 58–81, 1948 S.I.C.) and shipment weights. The major groups were then aggregated to the major group level using 1954 shipment weights.

These two series were then linked by using the ratio of the two during 1965.

For the period 1949–1955, output prices for transportation are the output prices of manufactured non-ferrous metal products and iron and steel products. Over the same period, the output prices for tobacco products are the CPI for tobacco, that is, they are a retail price including tax rather than a wholesale price.

The all manufacturing data were collected from the same sources as the two-digit data. The wholesale price index was also collected for the period 1949–1969.

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[3] The output and input price indexes were constructed by D. McFetridge.

[4] Canada, Dominion Bureau of Statistics. *Industry Selling Price Indexes, 1956–1959*. Ottawa, Queen's Printer, 1961. DBS 62-515.

Input Prices

The input price indexes are weighted averages of various output price indexes. Their construction was rather a lengthy procedure and was done as follows.

(A) *Derivation of the Weights*

The weights used in the calculation of two-digit input prices are shown in Table A.2. This is based on Table 8 of *The Input-Output Structure of the Canadian Economy 1961* (pp. 305–328).[5] Table 8 provides dollar values for 65 commodity and service classifications used by 65 industry groups. Table 8 is transformed into Table A.1 (shown below) by:

(a) grouping rows 1–66 of Table 8 into:
  (i) seven primary products (rows 1–7 in Table 8)
  (ii) fifteen manufactured product groups (rows 8–22 in Table 8)
  (iii) one group known as services (row 23 of Table 8)
  (iv) non-competing imports (row 24 of Table 8)
  (v) omitting completely rows 67–75 of Table 8.

(b) grouping columns 8–53 of Table 8 into manufacturing industry groups and omitting completely column 1–7 and 54–65. Also omitted from Table A.1 are columns containing the Miscellaneous Manufacturing, and the Printing and Publishing industries.

Table A.2 is obtained from Table A.1 by dividing each row entry by the corrected column sum shown in the bottom. The weights shown in Table A.2 are applied to the appropriate commodity prices to obtain two-digit input prices.

For the manufacturing sector as a whole all manufactured commodities are excluded. The material inputs then consist of primary products, services, and non-competing imports. Weights are obtained by summing rows 1–7 and 23–24 and dividing each row sum by the grand sum. For example, the weight of agriculture in the all manufacturing input price is given by:

$$\sum_{j=01}^{16} a_{1j} \Bigg/ \sum_{i=1}^{n} \sum_{j=01}^{16} a_{ij}$$

$$n = 7+23+24$$

(B) *Description of Commodity Classes*

As stated, commodity groups 1–7 contain unprocessed products, groups 8–22 contain manufactured commodities which approximate the two-digit Standard Industrial Classification. Row 23, entitled services, contains the following activities: construction, wholesale and retail trade, transportation and storage, communications, utilities, finance, insurance and real estate, business service, accommodation and meals, other services, office supplies, advertising and travel, operating supplies.

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[5] Canada. Dominion Bureau of Statistics. *System of National Accounts. The Input-Output Tables. Vol. I. The Input-Output Structure of the Canadian Economy, 1961.* Ottawa, Queen's Printer, 1969. DBS 15-501.

Non-competing imports are those which are not produced in Canada. Commodities which are imported but have domestic counterpart are included within the domestic commodity group. Examples of non-competing imports are raw rubber and raw cotton.

(C) *Description of Price Series Used*

In the interest of accuracy some commodity groups are characterized by differing price series, depending on the industry to which they are destined. A brief summary is as follows:

(a) Agriculture: The W.P.I.[6] of Canadian agricultural products is used except for industry 02 where the weight assigned to agriculture is applied to the W.P.I. of raw tobacco.

(b) Forestry: An experimental buyer's price of unprocessed logs was used for the period 1961–1969. Regression analysis showed this series to be closely related ($\overline{R}^2 = .96$) to the W.P.I. of lumber and timber. Consequently, the latter was used to project the forestry price backward to 1949. The experimental price index was obtained from the industrial prices section of Statistics Canada.

(c) Metal Ores and Concentrates: An experimental iron-ore price provided the only coverage available from quoted prices in this area.

(d) Coal: The W.P.I. for coal is used.

(e) Oil and Gas: The W.P.I. for crude oil is used.

(f) Fish and Fur: The W.P.I. for raw and partly processed fish provided the only available coverage for this commodity. For furs, the W.P.I. of unprocessed furs is used.

(g) Manufactured Commodities: Two-digit output prices are used. There is only one exception. The W.P.I. of hides and skins was assigned the weight of the food and beverage commodity group in calculation of input prices for industry 04 (leather).

(h) Services: The deflator for non-government services from the National Accounts is used.

(i) Non-Competing imports: The merchandise imports deflator is used except in cases where a more specific series is applied. These cases are: (1) use of W.P.I. raw rubber in industry 03, (2) use of W.P.I. raw cotton in industry 05.

Note that, with the exception of the services and merchandise imports deflators, all prices are quoted prices obtained from Statistics Canada Industrial Prices Section. A realized price series for "Mines, Quarries and Wells" (rows 4–7 on Table A. 2) was used at the three-digit level. It must also be noted that import prices do not have a large direct weight in the input prices calculated above. Commodities which are supplied in part by domestic producers and in part from imports are assigned the domestic industry selling price. It is possible, however, to segment each commodity group into domestic and imported com-

[6] W.P.I. is General Wholesale Price Index.

ponents thus providing a direct foreign price linkage. This has not been done with the series calculated above.

Two-Digit input prices

1. *price* definitions:
   (a) Agriculture: W.P.I. Canadian agricultural products
   (b) Forestry:
      (i) experimental buyers price of unprocessed logs 1961–69.
      (ii) 1949–1960 predicted forestry price using regression of (i) on W.P.I. "lumber and timber".

   $FP = 37.69579 + .15071$ [W.P.I. Lumber and Timber]

   $\overline{R}^2 = 0.96$

   (c) Metal Ores: experimental iron ore price 1953–69 only.
   (d) Coal: W.P.I. coal 1949–69
   (e) Oil and gas: W.P.I. crude oil 1949–69
   (f) Services: implicit deflator of all non-government services (i.e. services purchased by individual and services imported).

2. other prices of *raw products:*
   (a) fish: (used in food and beverage) W.P.I. raw and partly processed fish.
   (b) raw tobacco: (given the weight assigned to agriculture in industry 02) W.P.I. raw tobacco.
   (c) raw rubber: (given the weight assigned to *non-competing imports* in industry 03) W.P.I. raw rubber.
   (d) hides and skins: (given the weight assigned to food and beverage in industry 04) W.P.I. hides and skins.
   (e) raw cotton: (given the weight assigned to *non-competing imports* in industry 05) W.P.I. raw cotton.
   (f) furs: (given the weight assigned to fish and fur in industry 06) W.P.I. furs.

3. Prices of inputs from *other* two-digit industries
   (a) Two-digit output prices based on Statistics Canada industry selling price 1956-69 were aggregated to major groups using shipment weights, and linked to experimental output prices based on the W.P.I. components 1949-57.
   (b) Note that inputs purchased *within* an industry group are excluded.

(D) *Calculation* of two-digit input prices

The major group industry input prices (Pm) were calculated as follows:

01 *Food & Beverages* Pm = 0.564(AG) + 0.032(FISH) + 0.005(TEXT) + 0.003(WOOD) + 0.061(PAPER) + 0.036(METALS) + 0.008(NON-METALLIC) + 0.009(PETROL) + 0.022(CHEM) + 0.257(SERVICES)

02 *Tobacco* Pm = 0.586(RAW TOBACCO) + 0.012(F&B) + 0.148(PAPER) + 0.238(SERVICE)

03 *Rubber*	Pm =	0.007(COAL) + 0.016(LEATHER) + 0.197(TEXT) + 0.023(PAPER) + 0.040(METALS) + 0.007(PETROL) + 0.308(CHEM) + 0.105(RAW RUBBER) + 0.288(SERVICE)
04 *Leather*	Pm =	0.212(HIDES & SKINS) + 0.089(RUBBER) + 0.085(TEXT) + 0.009(APPAREL) + 0.009(WOOD) + 0.044(PAPER) + 0.024(METALS) + 0.071(CHEM) + 0.446(SERVICE)
05 *Textiles*	Pm =	0.015(AG) + 0.008(COAL) + 0.022(F&B) + 0.015(RUBBER) + 0.039(APPAREL) + 0.069 (PAPER) + 0.012(METALS) + 0.191(CHEM) + 0.187(RAW COTTON) + 0.437(SERVICES)
06 *Apparel*	Pm =	0.019(AG) + 0.024(FUR) + 0.682(TEXT) + 0.018(PAPER) + 0.240(SERVICE)
07 *Wood*	Pm =	0.459(FORESTRY) + 0.010(RUBBER) + 0.051 (TEXT) + 0.014(PAPER) + 0.066(METALS) + 0.010 (NON-METALLIC) + 0.015(PETROL) + 0.029 (CHEM) + 0.342(SERVICE)
08 *Paper*	Pm =	0.375(FORESTRY) + 0.021(COAL) + 0.010(OIL) +0.005(F&B) + 0.019(TEXTILE) + 0.049(WOOD) + 0.027(METALS) + 0.007(NON-METALLIC) + 0.027(PETROL) + 0.080(CHEM) + 0.380 (SERVICE)
10 *Metal Products*	Pm =	0.404(MET.ORES) + 0.031(COAL) + 0.102 (RUBBER) + 0.013(WOOD) + 0.016(PAPER) + 0.003(TRANS) + 0.022(NON-METALLIC) + 0.015 (PETROL) + 0.035(CHEM) + 0.445(SERVICE)
11 *Transportation*	Pm =	0.068(RUBBER) + 0.043(TEXT) + 0.009(WOOD) + 0.471(METALS) + 0.035(NON-METALLIC) + 0.007(PETROL) + 0.027(CHEM) + 0.382 (SERVICE)
15 *Petrol & Coal*	Pm =	0.743(CRUDE OIL) + 0.012(METALS) + 0.044(CHEM) + 0.196(SERVICES)
16 *Chemicals*	Pm =	0.017(COAL) + 0.009(OIL) + 0.072(F&B) + 0.010 (TEXT) + 0.078(PAPER) + 0.073(METALS) + 0.062 (NON-METALLIC) + 0.085(PETROL) + 0.584 (SERVICE)

NOTE: The above weights do not necessarily add up to 1.00. All input price series were therefore re-indexed to base 1956 = 100.

All Manufacturing Input Prices

The all manufacturing input price was calculated as follows:

(a) *For 1953-69*

Pm = 0.2307 (AG) + 0.0877 (FORESTRY)
+0.1027 (METAL ORES) + 0.0148 (COAL)
+0.0986 (CRUDE OIL) + 0.4659 (SERVICE)

(b) *For 1949-52*

Pm = 0.2570 (AG) + 0.0977 (FORESTRY)
+0.0165 (COAL) +0.1098 (CRUDE OIL)
+0.5190 (SERVICES)

(c) These series were linked in 1953 using overlapping ratios.

(d) all manufacturing input prices including non-competing imports:

(i) *1953-69*

Pm= 0.2250 (AG) +0.0855 (FORESTRY)
+0.0998 (METAL ORES) + 0.0144 (COAL)
+0.0961 (CRUDE OIL) +0.0249 (N.C. IMPORTS)
+0.4543 (SERVICE)

(ii) *1949-52*

Pm = 0.2499 (AG) +0.0950 (FORESTRY) +0.0160 (COAL)
+0.1068 (CRUDE OIL) +0.0276 (N.C. IMPORTS)
+0.5047 (SERVICES)

(iii) non-competing imports: the deflator of *merchandise imports.*

Explanation of weights

1. Table A.1 is a compressed version of DBS 15–501[7] volume I, Table 8 pp. 305–328.
2. Table A.1 was obtained by
   (a) grouping *rows* 1–66 of Table 8 into:
      (i) 7 primary products (rows 1-7 in Table A.1)
      (ii) 15 manufactured product groups to correspond to industries defined in section one.
      —see rows 8-22 of Table A.1.
      (iii) 1 group called "services"—row 23 of Table A.1
      (iv) non-competing imports—row 24 of Table A.1
   (b) grouping columns 8–53 of Table 8 into the major group industries Columns 01 to 16 therefore provide the dollar values of each commodity group [raw, manufactured, service, non-competing import] used by a specific industry.
3. The "services" group contains rows 54–65 of Table 8.
   These are:
   construction
   wholesale & retail trade
   transportation and storage
   communications
   utilities
   finance, insurance, real estate
   business service
   accommodation and meals
   other services
   office supplies
   advertising and travel
   operating supplies

[7] See footnote No. 5, page 239.

TABLE A-1

Purchased Inputs by Major Industrial Groups
(Millions of Dollars)

Major Groups

Commodity/Industry	01	02	03	04	05	06	07	08	10	11	14	15	16
Primary													
1 Agriculture	1,619.7	103.5			4.0	10.1	0.1	0.2	—	—	—	—	0.6
2 Forestry	0.7	—					316.2	343.9	0.2	—	0.3	—	0.1
3 Fish & Fur	92.8				0.2	13.2	—	—	—	—	—	—	—
4 Metal Ores & Concentrates	—						—	0.1	763.6	—	6.6	0.2	0.7
5 Non-Metallic Minerals	3.8		0.5	0.1	0.3		—	9.4	11.5	0.3	39.3	1.0	20.1
6 Coal	6.0	0.1	1.3	0.5	2.2	0.5	0.6	19.2	58.9	3.2	8.0	1.4	9.5
7 Oil & Gas	1.2		0.3				0.1	8.5	2.6	0.2	1.4	722.9	5.4
Major Group Industries													
8 01 Food & Beverage	824.6	2.1	0.3	24.5	5.8	0.9	1.1	5.0	1.0	—	0.4	0.5	41.5
9 02 Tobacco	—	75.8	—	—	—	—	—	—	—	—	—	—	—
10 03 Rubber	—	—	8.7	10.3	3.9	1.0	7.1	0.3	22.6	44.1	0.4	—	2.1
11 04 Leather	—	—	2.8	61.4	0.2	1.1	0.6	—	—	0.2	—	—	—
12 05 Textile	14.6	—	35.2	9.9	283.1	370.6	35.1	17.5	4.7	27.6	2.6	—	5.5
13 06 Apparel	0.1	—	0.8	1.1	10.5	88.3	—	—	—	—		—	0.1
14 07 Wood	7.4	1.0	0.1	1.0	2.0	—	174.8	45.1	23.9	5.9	1.1	0.2	1.3
15 08 Paper & Allied	174.4	26.2	4.1	5.1	16.3	9.9	9.6	317.2	29.6	4.0	17.7	1.4	44.7
16 09 Printing & Publishing	6.2	0.9	—	—	—	—	0.1	6.1	1.5	—	0.1	—	0.2
17 10 Metal Products	102.9	1.4	7.2	2.8	3.2	0.6	45.8	24.5	2,100.3	272.0	17.5	12.0	42.2
18 11 Transportation Equipment	—	—	0.3	—	—	—	—	—	5.2	567.8	—	—	—
19 14 Non-Metallic Minerals	22.4	—	0.2	0.1	0.7	—	7.2	6.2	41.9	22.9	80.9	—	15.4
20 15 Petroleum & Coal Products	25.6	0.3	1.2	0.4	—	1.0	10.0	25.2	27.6	4.8	10.2	13.8	49.1
21 16 Chemical Products	63.2	—	55.1	8.2	50.8	3.1	20.2	73.2	66.5	17.7	10.4	43.0	283.7
22 17 Miscellaneous Manufacturing	2.6	3.5	2.1	8.9	4.2	26.2	11.2	10.6	16.1	16.8	4.4	4.0	15.4
Other	740.0	42.1	51.5	51.7	116.2	130.6	235.5	348.7	841.4	249.2	176.9	190.8	335.9
Non-competing imports	122.1	0	18.8	0.1	49.9	0.1	0	0	.1	0	0.4	0	0.7
Total	3,829.7	256.9	190.5	186.1	553.5	658.2	875.2	1,260.9	4,019.1	1,236.7	378.6	991.2	814.0
Total ex. 09 & 17	3,820.9	252.5	187.5	177.2	549.3	632.0	864.0	1,244.2	4,001.5	1,219.9	374.1	987.2	858.6
Total ex. 09, 17 & self	2,996.3	176.7	178.8	115.8	266.2	543.7	689.2	927.0	1,901.2	652.1	293.2	973.4	574.9

Table A-2

Input Coefficients

Major Groups

Inputs	01	02	03	04	05	06	07	08	10	11	14	15	16
Primary													
1 Agriculture	0.541	0.586			0.015	0.019							
2 Forestry							0.459	0.371					
3 Fish & Fur	0.031					0.024							
4 Metallic Ores & Concentrates									0.402		0.023		
5 Unprocessed Non-metallic Minerals								0.010			0.134		0.035
6 Coal			0.007		0.008			0.021	0.031		0.027		0.017
7 Oil & Gas								0.009				0.743	0.009
Major Group Industries													
8 01 Food and Beverage	—	0.012		0.212	0.022								0.072
9 02 Tobacco		—											
10 03 Rubber			—	0.089	0.015		0.010	0.012	0.068				
11 04 Leather			0.016	—									
12 05 Textile	0.005		0.197	0.085	—	0.682	0.051	0.019		0.042	0.009		0.010
13 06 Apparel				0.009	0.039								
14 07 Wood				0.009			—	0.049	0.013	0.009			
15 08 Paper & Allied	0.058	0.148	0.023	0.044	0.061	0.018	0.014	—	0.016		0.061		0.078
17 10 Metal Products	0.034		0.040	0.024	0.012		0.066	0.026	—	0.417	0.060	0.012	0.073
18 11 Transportation Equipment										—			
19 14 Non-metallic Minerals							0.010	0.007	0.022	0.035	—		0.027
20 15 Petroleum & Coal Products	0.009		0.007				0.015	0.027	0.015	0.007	0.035	—	0.085
21 16 Chemical Products	0.021		0.308	0.071	0.191		0.029	0.079	0.035	0.027	0.035	0.044	—
3 Other	0.247	0.238	0.288	0.446	0.437	0.240	0.342	0.376	0.443	0.382	0.603	0.196	0.584
4 Non-competing Imports	0.041		0.105		0.187								

4. non-competing imports are those which are not produced in Canada—examples are raw rubber and raw cotton.

All other *imports enter only indirectly*—in that their price affects in some way the price of the domestically produced competitor.

PRODUCT DEMAND DATA

As described in chapter five, three measures of excess demand in the product market were used. These were,

(i) H_t / H_t^*

(ii) FG_t / FG_t^*

(iii) UO_t^* / UO_t^*

where H_t =ratio of total inventories to shipments at time t

FG_t=ratio of finished goods inventories to shipments at time t

UO_t=ratio of unfilled orders to shipments at time t

* =denotes the equilibrium level and is defined to be an eight-quarter moving average of the corresponding variable.

Thus the basic data comprising the demand variables include total inventories, finished goods inventories, unfilled orders and shipments. The basic sources for these data was *Inventories, Shipments and Orders in Manufacturing Industries.* (DBS 31–001).

Monthly data on total inventories owned, finished goods inventories, unfilled orders and shipments are available and quarterly data were obtained as an average of the three months in the quarter. However, the monthly figure for the first three series is the stock at the end of the month, so that the three-month averages are centered at the end of the second month in the quarter. On the other hand, shipments data, being flows are shipments for a month and can be regarded as centered in the middle of the month, so that the three-month average is centered in the middle of the second month. This creates a minor alignment problem in the definition of our demand variables H_t etc., one which arises from the fact that these variables are defined as the ratio of stocks to flows. However, the error introduced by this construction is almost certainly negligible.[8]

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[8] At the all manufacturing level we did in fact attempt to get around this problem by using the trapezoidal rule to center the inventories stocks at the middle of the month. The difference was negligible, causing us to use simple averaging procedures in the rest of our work.

All the variables were available at the two-digit level (on 1960 S.I.C.) from 1958-1969. They were available (on 1948 S.I.C.) from 1955-1961. They were available (1948 S.I.C.) from 1952-1955 (D.B.S. 31–001, December 1955). These three series were linked using ratios calculated from the overlap year. Moreover, for certain two-digit industries, these series were available in index form (D.B.S. 31–001, December 1951) for the years 1949, 1960 and 1951. Using the dollar values and indexes from 1952, these indexes were converted to dollar values. This precluded the necessity of any linking procedure.

The net result was a data set containing consistent series with a variable starting data (1949-1958) and ending in 1969. The orders data does not exist, however, for those industries producing primarily to stock.

The all manufacturing data was collected from the same source *Inventories, Shipments and Orders in Manufacturing Industries*. (DBS 31–001).

FINANCIAL DATA

The gathering of financial statistics presented special problems and needs fairly detailed explanation. The difficulty was that two data series existed for each of the basic variables in this category. The so-called "old" series running from 1950-1967 (this is a maximum length, several started later than 1950) was collected from *Corporation Profits* (DBS 61–003) and *Taxation Statistics*, (Dept. National Revenue). The "new" series ran from 1962-1969 and was obtained from *Industrial Corporations Quarterly Financial Statistics 1962-1969*, Vol. 16, No. 4, June 1970.[9]

Four series were gathered in each. These were Cash Flow (CF), Cash Flow After Tax (CFAT), Equity (E) and Sales (S).

New

CF—"Base Profit"

CFAT—"Base Profit" less "Income Taxes Accrued on Present Period"

E—"Total Shareholders Equity"

S—"Sales of Goods & Services"

Old

CF—"Net Earnings"

CFAT—"Net Earnings" less "Income Tax Liabilities"

E*—"Preferred Stock" plus "Common Stock" plus "Surplus" less "Deficit"

S—"Sales"

E* prior to 1962 was the only data gathered from the Department of National Revenue, *Taxation Statistics*.

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[9] With this issue the title changed from *Corporation Profits* to *Industrial Corporations, Quarterly Financial Statistics*, and quarterly data from 1962–1969, inclusive, was provided. DBS 61-003.

From these four basic data series, five financial data series were created for use in our empirical work. These were:

1. CF/E
2. CFAT/E
3. CF/S
4. CFAT/S
5. eff

"eff" is the effective tax rate and is calculated simply as one minus the ratio of CFAT/E to CF/E (i.e. 1-2/1).

The problem, as can readily be seen, was to create a consistent series spanning the whole range 1950-1969. Also we wanted our final series to be comparable to the "new" rather than the "old" data.

The first method used was to run a regression on the raw data for the period of overlap (1962-1967) and, from the coefficients, calculate a revised series (new plus calculated) which was then seasonally adjusted. We did obtain our All Manufacturing series by this method but at the two-digit level the results were so poor as to be unusable.

It was then decided to link the two-digit industry series by means of the ratio of the four-quarter average of the seasonally-adjusted "new" to "old" series during the first year of overlap (1962). This ratio was then used to calculate a "revised old" series. This "revised old" series from 1950-1961 was tacked on to the beginning of the "new" series to give us our "final" series.

The four profit variables, are given as quarterly rates. For example, CFAT/E data appears in the form 0.0523 or a 5.23 per cent rate of return.

OUTPUT, CAPACITY AND CAPACITY UTILIZATION DATA

The output and capacity data were used exclusively in the productivity functions. The capacity utilization data were used multiplicatively with the demand variables in some preliminary price equations. However, as discussed in chapter two, this approach was not pursued in later stages and we do not report any results where this has been done.

Two basic data series were used.

(i) Output, Q, was measured by the Index of Industrial Production, and quarterly data were obtained from the Prices and Incomes Commission tape 637.

(ii) Capital Stock in Constant Dollars, K, was obtained from *Fixed Capital Flows and Stocks; Manufacturing, Canada 1926-1960.*[10] This latter series

[10] Canada. Dominion Bureau of Statistics. *Fixed Capital Flows and Stocks, Manufacturing, Canada, 1926–1960.* Ottawa, Queen's Printer, 1966. DBS 15-523.

was updated by Professor J. A. Sawyer, University of Toronto. The Capital Stock series were annual and were converted to quarterly data by interpolation.

The method of estimating capacity and capacity utilization, follows closely the so-called Wharton method, developed by Klein and Summers (1966). Ln (Q), ln (K), ln (Q/K) were plotted against time and local peaks in the ln (Q) series were determined. All observations which fell below the preceding local peak in the ln (Q) series were noted. Then two regressions were run:

(a) $\ln Q/K = A + Bt$ —for all observations 1949-1969

(b) $\ln Q/K = A^1 + B^1 t$ —excluding those observations

where ln(Q) fell below the preceding local peak. Trends in the output-capital ratio were calculated as follows:

$$\text{Trend (a)} = \text{anti} \ln [A + Bt]_{(a)}$$
$$\text{Trend (b)} = \text{anti} \ln [A^1 + B^1 t]_{(b)}$$

Note that in (b) the trend was calculated for all values of t, including those values which were not included in the original regression. At this point it was determined that series (b) was a better estimate and thus, only the series derived from (b) were used in further analysis.

The capacity series was calculated as:

$$CP_t = K_t * \text{Trend}_{(b)} (Q/K)_t .$$

Capacity Utilization was calculated simply as the ratio of output to capacity expressed as a percentage.

One further point to note is that the normal 15 major group industries could not be obtained in this series. Tobacco, Rubber and Leather were aggregated together as were Non-Metallic Minerals and Petroleum & Coal. We used the aggregate capacity series for each of the industries in that aggregation, in other words, the Tobacco-Rubber-Leather series was used, as it stood, for each of Tobacco, Rubber and Leather.

MISCELLANEOUS DATA

This section summarizes some of the miscellaneous series used in the study.

Exchange Rate

This is measured by the price of Canadian dollars in terms of U.S. dollars. Monthly data were obtained from various issues of the Bank of Canada *Statistical Summary* and were averaged into quarterly series. As discussed in chapter five, a 16-quarter moving average of the resulting series proved to be the most satisfactory specification used in the price equations.

Bond Rate

This is taken to be the yield on long term corporate industrial bonds and was obtained from McLeod, Young and Weir, Co.

STRUCTURAL DATA

Several structural variables were examined to determine comparative industry size in various aspects of their operations. These variables were: degree of unionization, concentration, imports, exports, average hourly earnings, employment. All but the first two of these were calculated as a percentage of the all manufacturing value.

Degree of Unionization

The number of unionized employees (measured annually as of January 1, of each year) was obtained on a 1948 SIC basis for total manufacturing, durable, nondurable and 17 two-digit manufacturing industries for the period 1953-1960 from *Labour Organizations in Canada* and for 1961 from *Labour Gazette*, publications of the Department of Labour.

The number of unionized employees on a 1960 SIC basis was obtained for total manufacturing, durable, nondurable and 20 two-digit manufacturing industries for the period 1962-1969 from the *Labour Gazette*.

In accordance with the procedures described in section one the two-digit data for each of the two subsets was aggregated to 15 two-digit groups. In this case simple summation was all that was required.

The 1953-1961 data were divided by the appropriate production worker employment series, based on the 1948 SIC, derived from the ledgers of the labor division of Statistics Canada.

The 1962-1969 data were divided by the appropriate production worker employment series, based on the 1960 SIC, derived from PIC tape 637.

No linking, other than simply appending one series to another, was possible as there was no SIC overlap.

Concentration

A three-digit industry Herfindahl index of shipments was obtained from unpublished tabulations provided by Mr. William Morrow of the Department of Consumer and Corporate Affairs. To aggregate this to the two-digit level, shipment weights were used.

Imports and Exports

Annual data from 1964-1969 for the two-digit industries and all manufacturing were provided by staff of the Prices and Incomes Commission. The import and export comparison series were created by taking the 1964 value for the two-digit industry as a percentage of the value for all manufacturing that year.

Shipments, Average Hourly Earnings, Total Employment

The values for these series were averages of the four quarters of 1961 for the two-digit industries as a per cent of the corresponding all manufacturing series. A further description of these series is available elsewhere in this Appendix.

Table A.3

Structural Data

	Shipments Aug. 1961	% of All Man. Shipments	Weighted Herfindahl (concentration)	Import % of All Man.	Export % of All Man.	AHE Total ratio: industry	Employment % of total
All Man.	58.7	100.00	—	100.00	100.00	1.000	100.00
2-*Digit*							
Food & Bev.	12.6	21.4	9.93	5.22	11.61	0.895	14.8
Tobacco	0.8	1.4	28.91	0.15	0.61	0.986	0.8
Rubber	0.8	1.4	16.78	0.93	0.25	1.013	1.8
Leather	0.7	1.2	4.87	0.70	0.24	0.664	2.4
Textiles	2.2	3.7	16.60	6.88	1.08	0.787	5.0
Apparel	2.5	4.3	1.22	0.72	0.27	0.645	8.0
Wood	3.5	5.9	3.03	1.71	10.69	0.844	7.8
Paper	5.5	9.4	5.73	1.25	28.83	1.158	8.1
Print. & Pub.			1.05	2.15	0.18	1.107	4.9
Metals	15.4	26.3	12.43	39.99	32.12	1.127	25.6
Transportation	4.6	7.9	25.61	19.15	10.09	1.161	8.1
Non-Met. Min.	1.7	2.9	13.98	2.40	1.01	1.016	3.1
Petrol & Coal	3.0	5.2	19.65	2.41	0.38	1.456	1.3
Chemicals	3.6	6.1	10.01	7.23	4.96	1.158	4.9
Miscellaneous	1.5	2.5	7.78	9.98	1.70	0.885	3.3
				(100.87)	(100.02)		(99.9)

Table A.4

Degree of Unionization (per cent)

Annual 1953–1969
(as of Jan. 1)

Year	All Man.	Durable	Non-Durable	Food & Bev.	Tobacco	Rubber	Leather	Textiles	Apparel
1953	56.37	57.36	55.00	51.01	64.36	76.30	33.46	39.60	50.77
1954	56.76	57.15	56.32	53.77	59.27	70.68	44.52	50.52	50.43
1955	60.38	63.95	56.72	53.71	47.46	76.61	35.79	49.06	50.06
1956	65.03	67.34	62.57	62.11	61.97	85.17	35.75	52.30	63.51
1957	67.02	67.86	66.09	63.83	60.85	88.39	40.64	63.69	64.68
1958	67.51	69.79	65.18	62.15	67.90	87.64	39.27	58.30	62.46
1959	68.81	72.34	65.39	66.49	59.10	80.72	41.16	51.38	62.76
1960	68.99	71.57	66.56	66.22	59.07	86.26	40.83	62.80	57.64
1961	71.41	76.33	67.00	68.53	53.57	100.00	35.57	66.24	60.22
1962	72.49	74.16	71.05	78.69	58.88	77.09	39.05	65.14	61.98
1963	71.12	71.84	70.46	76.77	59.98	82.12	42.31	64.83	57.22
1964	71.72	72.97	70.56	76.98	60.32	81.38	47.73	69.03	57.33
1965	73.05	74.25	71.87	77.60	58.32	84.87	43.97	75.25	58.70
1966	71.45	72.40	70.47	75.86	67.40	87.98	50.88	70.92	57.58
1967	73.85	78.03	69.52	74.75	65.95	86.76	52.66	71.54	59.30
1968	76.12	81.98	70.84	77.24	71.65	85.86	50.63	71.20	61.23
1969	74.68	79.29	69.96	78.73	72.47	82.50	53.12	61.43	60.49

TABLE A.4 (cont'd)

Degree of Unionization (per cent)

Annual 1953–1969
(as of Jan. 1)

Year	Wood	Paper	Print. & Pub.	Metals	Trans-port.	Non-Metallic Minerals	Petro-leum & Coal	Chem-icals	Miscel-laneous
1953	47.51	86.83	74.70	53.83	67.14	66.39	41.02	43.36	21.88
1954	44.17	78.96	73.94	53.15	67.61	68.72	38.57	48.53	14.63
1955	47.42	84.65	71.04	60.29	83.13	56.20	38.39	44.98	17.00
1956	50.44	83.52	84.87	62.27	90.10	57.72	38.42	46.32	23.59
1957	58.74	89.91	80.17	65.67	76.36	68.76	41.10	48.72	25.17
1958	50.00	95.46	83.30	68.13	85.52	63.72	59.05	41.95	24.46
1959	44.48	88.18	100.00	75.08	87.08	61.05	46.72	45.63	23.86
1960	44.59	88.27	100.00	76.16	83.64	55.77	58.79	52.80	23.32
1961	46.22	90.18	90.43	82.23	87.52	65.51	55.83	50.14	21.43
1962	49.92	100.00	89.79	74.38	97.85	69.58	59.83	54.03	23.13
1963	45.96	100.00	94.81	72.72	93.47	69.76	59.01	59.24	22.63
1964	49.37	100.00	91.15	72.73	94.72	69.36	64.94	60.05	22.65
1965	50.13	99.49	91.52	71.17	100.00	78.70	62.59	67.20	23.15
1966	47.82	98.26	86.47	68.99	98.97	79.51	59.54	61.10	22.46
1967	65.93	87.77	86.49	69.79	100.00	70.37	61.19	67.34	25.10
1968	71.32	87.07	88.94	74.90	100.00	69.18	57.41	65.86	24.68
1969	57.94	89.99	86.02	74.54	100.00	75.70	57.84	66.74	29.63

CONTRACT DATA

In this section we describe the so-called "contract data" which were used to derive the weights $k_{t,t-\tau}$ applied to the independent variables in the wage equations.

In 1966 the Department of Labour in conjunction with the Economic Council of Canada, compiled a comprehensive summary on computer tape of a number of what was considered to be "relatively standard and economically important features of collective agreements",[11] for 2,635 successful negotiations in Canada for all industries except construction and railroads, over the period 1953 to the end of 1966. To be included in the summary a successful negotiation had to cover 500 or more employees. (A negotiation is successful if it results in at least one signed collective agreement. It may result in more than one signed collective agreement if the negotiation involves multiple establishments and/or multiple unions). This computer tape was updated by the Department of Labour in 1969 to include information through 1968. This involved adding another 776 successful negotiations.

[11] See Economic Council of Canada, Annual Review; 3rd. 1966. *Prices Productivity and Employment*, Ottawa, Queen's Printer, 1966. pp. 127–132.

A wealth of information describing those contracts is contained on the tape and we have eliminated the non-manufacturing industries that are included. In particular, we have been able to construct the following crucial variable for the total manufacturing as well as for our 15 major group industries.

$k_{t,t-\tau}$ = proportion of production workers at time t under contract signed at time $t-\tau$, where t,τ, are measured in quarters.

This variable was constructed by summing for each quarter the number of workers in the relevant manufacturing industry who were under contract and then determining the breakdown of this total by quarter of signing. Each of the subtotals for quarter of signing was expressed as a percentage of the total under contract. To avoid double counting, workers signing new contracts in the quarter under consideration were included in the total under contract, but workers whose contracts expired that quarter were not.

In addition, several other variables, such as the average length of contract and proportion of workers under contracts which have escalator clauses have been constructed, but these were not used in the present study.

While these contract data are clearly very valuable, nevertheless, they have several limitations and these should be kept in mind.

(i) All the wage data on the tape refer to the least skilled classification of workers in the particular negotiating unit. This does not cause any particular problem for the present study, where our sole concern are the weights $k_{t,t-\tau}$, but it is a severe drawback in any analysis which attempts to explain negotiated wage changes. It should be recalled that our procedure has been to relate negotiated wage changes $\Delta R^*_{t,t-\tau}/R^*_{t-1,t-\tau}$ to actual economic conditions thereby avoiding this problem.

(ii) The contract data on tape cover only unionized employees in large negotiating units (500 workers or more). It is not clear to what extent contracts for this group are representative of contracts for unionized employees in small negotiating units or for those of non-unionized production workers. For the first quarter of 1967 the unionized workers on tape represented 45.8 per cent of unionized manufacturing employees and 33.8 per cent of all manufacturing production workers.

(iii) The sample of contracts contained on this tape is not the same as that now used by the Department of Labour for their publications, *Collective Bargaining Review* (monthly) and *A Note on Statistics of Wage Developments Under Major Collective Agreements* (quarterly). Unfortunately, the Department of Labour does not intend to update this tape to include the post 1968 period.

Finally, in order to give some indication for the magnitudes of the contract weights $k_{t,t-\tau}$, and how they change through time, we tabulate their quarterly values at the all manufacturing level over the period 1956-1968.

TABLE A.5

Contract Weights, 1956–1968

Quarter	$k_{t,t}$	$k_{t,t-1}$	$k_{t,t-2}$	$k_{t,t-3}$	$k_{t,t-4}$	$k_{t,t-5}$	$k_{t,t-6}$	$k_{t,t-7}$	$k_{t,t-8}$	$k_{t,t-9}$	$k_{t,t-10}$	$k_{t,t-11}$	$k_{t,t-12}$	$k_{t,t-13}$	$k_{t,t-14}$	
56:1	0.161	0.083	0.206	0.184	0.132	0.136	0.044	0.009	0.039	0	0	0.003	0.003	0	0	
56:2	0.295	0.166	0.073	0.162	0.039	0.067	0.116	0.039	0	0.038	0	0	0	0.003	0	
56:3	0.333	0.268	0.146	0.044	0.085	0.034	0.019	0.063	0.002	0	0.002	0	0	0	0.003	$k_{t,t-15}$ .003
56:4	0.136	0.327	0.260	0.133	0.017	0.083	0.031	0.009	0	0	0	0.002	0	0	0	
57:1	0.087	0.138	0.320	0.245	0.087	0.012	0.079	0.025	0.004	0	0	0	0	0	0	$k_{t,t-16}$ .003
57:2	0.114	0.087	0.139	0.317	0.145	0.077	0.010	0.053	0	0.004						
57:3	0.170	0.111	0.677	0.122	0.261	0.173	0.069	0.006	0.004	0	0.004					$k_{t,t-17}$ .003
57:4	0.068	0.165	0.108	0.075	0.106	0.254	0.153	0.065	0.002	0	0	0.004				$k_{t,t-18}$ .002
58:1	0.060	0.076	0.174	0.110	0.062	0.098	0.212	0.150	0.055	0.002						
58:2	0.103	0.085	0.099	0.091	0.103	0.076	0.123	0.213	0.031	0.072	0.003					
58:3	0.295	0.114	0.092	0.098	0.080	0.094	0.046	0.064	0.082	0.031	0.004					
58:4	0.245	0.262	0.101	0.082	0.038	0.064	0.083	0.013	0.020	0.063	0.027					
59:1	0.238	0.211	0.225	0.075	0.040	0.019	0.055	0.038	0.006	0.016	0.054	0.023				
59:2	0.104	0.276	0.239	0.105	0.052	0.025	0.022	0.058	0.025	0.007	0.018	0.048	0.023			
59:3	0.100	0.146	0.260	0.088	0.045	0.016	0.020	0.032	0.023	0.006	0.017	0	0.022			
59:4	0.177	0.088	0.128	0.209	0.192	0.074	0.037	0.009	0.014	0.028	0.020	0.003	0	0	0.019	
60:1	0.073	0.178	0.089	0.124	0.197	0.195	0.031	0.029	0.002	0.014	0.029	0.021	0	0		$k_{t,t-15}$ .019
60:2	0.141	0.082	0.179	0.077	0.098	0.191	0.142	0.025	0.005	0.002	0.015	0.025				$k_{t,t-16}$ .020
60:3	0.093	0.167	0.084	0.181	0.077	0.063	0.152	0.138	0.007	0.005	0.002	0.111				$k_{t,t-17}$ .020
60:4	0.106	0.092	0.164	0.086	0.169	0.072	0.057	0.141	0.103	0	0.005	0.002				$k_{t,t-18}$ .003

61:1	0.073	0.112	0.085	0.170	0.072	0.175	0.071	0.035	0.095	0.107	0	0.005	
61:2	0.156	0.091	0.122	0.084	0.098	0.085	0.052	0.052	0.030	0.109	0.120		
61:3	0.243	0.137	0.077	0.102	0.064	0.082	0.071	0.039	0.018	0.025	0.090	0.051	
61:4	0.157	0.242	0.137	0.060	0.102	0.064	0.080	0.056	0.023	0.012	0.019	0.047	
62:1	0.182	0.166	0.247	0.107	0.046	0.091	0.066	0.037	0.015	0.021	0.011	0.011	
62:2	0.189	0.220	0.172	0.043	0.113	0.051	0.090	0.062	0.009	0.018	0.021	0.012	
62:3	0.235	0.189	0.180	0.141	0.030	0.091	0.040	0.034	0.036	0.004	0.012	0.009	
62:4	0.052	0.230	0.185	0.186	0.133	0.029	0.083	0.039	0.022	0.034	0.004	0.004	
63:1	0.053	0.059	0.233	0.163	0.180	0.134	0.028	0.076	0.015	0.021	0.034	0.004	
63:2	0.138	0.065	0.059	0.195	0.110	0.182	0.113	0.200	0.058	0.015	0.014	0.029	0.002
63:3	0.122	0.145	0.060	0.055	0.177	0.101	0.166	0.104	0	0.047	0.011	0.013	
63:4	0.054	0.125	0.148	0.060	0.054	0.177	0.096	0.162	0.086	0	0.037	0.002	
64:1	0.030	0.061	0.131	0.156	0.061	0.058	0.188	0.071	0.124	0.093	0	0.027	
64:2	0.176	0.030	0.051	0.141	0.139	0.073	0.067	0.071	0.020	0.133	0.092		
64:3	0.256	0.178	0.030	0.040	0.116	0.114	0.057	0.047	0.030	0.017	0.062	0.053	
64:4	0.125	0.265	0.185	0.029	0.042	0.120	0.114	0.041	0.026	0.020	0.015	0.018	
65:1	0.157	0.114	0.243	0.166	0.027	0.038	0.107	0.062	0.033	0.020	0.014	0.011	0.007
65:2	0.103	0.176	0.123	0.252	0.154	0.027	0.035	0.080	0.006	0.029	0.016		
65:3	0.139	0.115	0.155	0.107	0.210	0.135	0.018	0.031	0.055	0.005	0.023	0.008	
65:4	0.085	0.134	0.111	0.149	0.103	0.202	0.118	0.012	0.011	0.051	0.003	0.023	
66:1	0.040	0.095	0.142	0.118	0.155	0.107	0.186	0.084	0.005	0.012	0.054	0.002	
66:2	0.191	0.046	0.093	0.139	0.087	0.152	0.105	0.068	0.060	0.005	0.011	0.042	
66:3	0.240	0.165	0.040	0.081	0.121	0.076	0.082	0.088	0.045	0.049	0.005	0.008	
66:4	0.056	0.240	0.162	0.039	0.081	0.117	0.072	0.080	0.078	0.040	0.034	0.002	
67:1	0.026	0.058	0.245	0.167	0.034	0.082	0.100	0.073	0.083	0.080	0.027	0.025	
67:2	0.057	0.028	0.060	0.254	0.172	0.033	0.081	0.076	0.063	0.081	0.074	0.021	
67:3	0.070	0.067	0.027	0.057	0.240	0.162	0.029	0.077	0.072	0.060	0.071	0.070	
67:4	0.022	0.084	0.080	0.032	0.068	0.289	0.192	0.017	0.073	0.084	0.057	0.001	
68:1	0.164	0.020	0.081	0.068	0.029	0.061	0.254	0.163	0.007	0.057	0.071	0.025	
68:2	0.166	0.193	0.023	0.086	0.075	0.034	0.051	0.171	0.155	0.008	0.017	0.017	0.002
68:3	0.240	0.135	0.153	0.021	0.068	0.059	0.026	0.033	0.126	0.122	0.006	0.009	
68:4	0.058	0.235	0.132	0.150	0.021	0.067	0.058	0.020	0.180	0.119	0.117	0.006	

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